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**A STUDY OF THE CHARACTERISTICS OF LIQUID
WASTES FROM AN INTEGRATED STEEL MILL**

G. N. McDermott, et al

**Environmental Health Center
Cincinnati, Ohio**

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Industrial Waste Survey Report

GENEVA WORKS

COLUMBIA-GENEVA DIVISION

UNITED STATES STEEL COMPANY

May 21 to June 23, 1951

A Study of the Characteristics
of Liquid Wastes from an
Integrated Steel Mill

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By

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ABSTRACT

This survey was made in connection with the program of industrial waste studies being conducted by the Public Health Service in co-operation with State health departments and other agencies concerned. Three major sources of wastes were surveyed, namely: the blast furnace area, coke, and rolling mill departments. The water supply systems and waste lines were also examined. Summaries of each of these studies are given below.

Blast Furnace Wastes

Water-carried wastes from three operating blast furnaces were sampled and analyzed for the period of May 22 through May 31, 1951. The wastes originated from the wet washing of flue gases from the furnaces, prior to their use in plant combustion units. There were two types of gas washers. The primary ones were of the counter-current tower type which removed fine dust particles by the intimate mixing of gas with sprays of water. The secondary washers were of the electrical precipitator type in which the tubes were flushed continuously by thin films of water. The wash water wastes were then passed through clarifiers where a large part of the settleable solids were removed and pumped as a sludge to a disc vacuum filter. The filter cake was used in the sintering plant while the filter effluent was diverted to the clarifier influent. The clarifier effluent was diverted in approximately equal proportions to the blast furnace

area drain and the untreated water system. Sludge from the clarifiers was pumped to the blast furnace drain whenever the sintering plant was shut down.

Weighted samples were collected hourly over 24-hour periods and composited. Flows were obtained from recording flow meters.

The average unit values for water used, and significant wastes produced by gas washing operations, are summarized as follows:

	Unit Values per Ton Hot Metal			
	Water Used	W a s t e s		
	Gal/ton	Suspended Solids lbs/ton	Total Iron lbs/ton	Cyanides (CN) lbs/ton
Furnace Cooling*	8,576			
Primary Gas Washers	3,946	25.7	17.1	0.047
Electrical Precipitators	<u>788</u>	<u>0.44</u>	<u>0.095</u>	<u>.002</u>
Total	13,310	26.14	17.195	0.049

* Treated water returned to treated water system and not run to waste.

The percentages of iron in the suspended solids are as follows:

Primary gas washer effluent	66.7
Electrical precipitators	21.4
Sludge removed by clarifiers	59.1

The average per cent removals of significant waste constituents from the gas washer effluents by the clarifiers are summarized as follows:

Average Flow, MGD	Average Detention Period, Minutes	Suspended Solids	Total Iron (Fe)
13.164	120	90.3	88.6

The average daily net and unit quantities of significant waste constituents discharged from the blast furnace area are as follows:

	Net Quantities lbs.	Quantities per Ton Hot Metal, lbs.
Suspended solids	5590	2.01
Total iron (Fe)	4640	1.67
Cyanides (CN)	59	.0212
Sulfides (S)	52	.0187

Coke Plant Wastes

This by-product coke plant was operating 252 Koppers coke ovens, producing coke, gas and coke by-products. The coking charge consisted of 82 per cent high volatile coal, 14 per cent low volatile coal and 4 per cent pitch, and averaged 4940 tons per day. The average daily yield of coke was 3281 tons while the average daily yield of by-products was 56,876,000 cubic feet of gas, 52,719 gallons of tar, 108,767 pounds of ammonium sulfate, 19,086 gallons of light oil, and 274 gallons of sodium phenolate.

Light oil recovered from the gas was refined in the benzol plant and yielded the following proportions of materials: benzol 58.66 per cent, toluol 16.64 per cent, xylol 2.89 per cent, heavy solvent naphtha 2.33 per cent, naphthalene 4.28 per cent, residue 8.75 per cent, and tars 6.40 per cent.

Samples were collected in the coke plant area for the period of June 3 through June 15, 1951.

The semidirect method of ammonia recovery from the gas was used. The average daily production of ammonia liquor was 103,680 gallons but a volume increase of 28 per cent in the ammonia still resulted in a final volume of 132,710 gallons or 26.63 gallons per ton of coal charged. The ammonia still removed 98.9 per cent of the free ammonia, 83.6 per cent of the fixed ammonia nitrogen and 94.3 per cent of the total ammonia nitrogen.

The Koppers vapor recirculation process was used for phenol recovery. The average phenol reduction in this unit during the period of the survey was 70.2 per cent.

The final cooling water was recirculated through a Marley cooling tower. Treated cooling water was periodically fed into this system, to make up for cooling tower evaporation losses, and supply additional water for the north quench station when other wastes were not sufficient to meet quenching demands. The average daily quantities and unit quantities of significant waste constituents removed from the gas in the final coolers during the period of the survey are as follows:

	Average daily quantities lbs.	Unit Quantities	
		lbs/million cu.ft. gas	lbs/ton coal charged
Cyanides (CN)	1100	19.4	0.223
Sulfides (S)	129	0.23	.026
Phenols	990	17.0	.196
B.O.D., 5-day	1900	33.9	.390

The average daily quantities and unit quantities of significant waste constituents released from the benzol plant during the period of the survey are as follows:

	Quantities lbs./day	Lbs/100 gal. Light Oil
Cyanides (CN)	43.	2.25
Sulfides (S)	14.4	.75
Phenols	278.	14.6
Thiocyanates (NH ₄ SCN)	55.6	2.91
B.O.D., 5-day	1240.	64.8
Ammonia Nitrogen (free)	58.8	3.08
Oil	242.	12.7

The sources and quantities of significant waste constituents discharged from operational units in the coke plant are as follows:

	Phenols lbs./day	Cyanides (CN) lbs./day	Thiocyanates (NH ₄ SCN) lbs./day	B.O.D. 5-day lbs./day
Ammonia liquors (from still)	238.	4.22	1120.	1400.
Water from final coolers	990.	1100.		1900.
Benzol plant sewer	<u>278.</u>	<u>43.0</u>	<u>55.6</u>	<u>1240.</u>
Total	1506.	1147.22	1175.6	4540.
Unit quantities per ton charge	0.305	0.232	0.238	0.919

All ammonia liquor was used for quenching coke. Final cooling water and benzol plant wastes were also used for quenching but when the flow from these two sources exceeded quenching demands the excess flowed to a settling-skimming pond. The overflow from this pond, called the benzol plant pond, constituted all the water-carried wastes discharged from the coke plant to the outfall sewers.

The average daily concentrations, gross and net quantities, and unit net quantities of significant waste constituents discharged from the coke plant to the main outfall sewer, are as follows:

	Concen- tration, p.p.m.	Quantities		Pounds per Ton Coking Charge
		Gross lbs.	Net lbs.	
Cyanides (CN)	6.1	0.81	0.81	0.00016
Sulfides (S)	.56	.28	.28	.000057
Phenols	315.	44.7	44.7	.0090
Thiocyanates (NH_4SCN)	132.	15.1	15.1	.0031
B.O.D., 5-day	992.	136.	134.	.027
Ammonia nitrogen (N)	24.8	3.6	3.6	.00073
Oil	67.3	12.9	12.9	.0026

Rolling Mill Wastes

Liquid wastes entering the outfall sewers from rolling mill operations originate in uses of water for cooling rolls of the mills, cleaning the rolls and product of mill scale, cooling sheet steel products, and lubrication of phenolic bearings. These wastes con-

tain polluttional materials consisting principally of mill scale and oil. Mill scale is particles of iron oxide and iron which flake and peel from the steel during rolling operations. The oil comes from losses in the lubrication system of the rolling mill. Other uses of water in the mills are part of a closed system and do not enter the outfall sewers. These uses are for cooling bearings and heat exchangers in the motor room and for cooling skid pipes of the reheating furnaces.

Rolling operations are performed in three departments: (1) the slab-bloom mill, (2) the plate and hot strip mill, and (3) the structural mill. Slabs and blooms are formed in the slab-bloom mill. Slabs are rolled to sheet or plate in the plate and strip mill. Blooms are rolled to structural shapes in the structural mill. Samples of the wastes from the three departments were collected hourly and composited over 24-hour periods during the period from June 17 to June 21. Averages of analytical, flow and production data obtained are presented in tables below.

Prior to discharge to the outfall sewers, the wastes are passed through rectangular settling basins known as scale pits in order to recover part of the mill scale they contain. The data in the tabulation below concern the discharge from the scale pits and do not reflect the reductions obtained by treatment given the total steel plant wastes in settling and oil-skimming ponds.

**Net Average Concentrations of Solids
Oil and Iron in Rolling Mill Wastes**

Waste	Flow mgd	Suspended Solids ppm	Iron ppm	Oil ppm
Slab-Bloom Mill	3.9	78	77	85.8
Plate-Strip Mill	11.5	135	174	58.4
Structural Mill	0.97	40	88	18.9
Total Rolling Mill Wastes (computed from above data)	16.4	116	146	62.5

**Daily Net Average Quantities of Solids
Oil and Iron in Rolling Mill Wastes**

Waste	Flow mgd	Suspended Solids lbs/day	Iron lbs/day	Oil lbs/day	Production tons/day
Slab-Bloom Mill	3.9	2,530	2,500	2,700	3,782
Plate-Strip Mill	11.5	12,900	16,600	5,590	5,089
Structural Mill	0.97	323	710	153	493
Total Rolling Mill Wastes (computed from above data)	16.4	15,800	19,900	8,540	

Plant Water Use

There were four separate water systems, namely: untreated, treated, domestic, and boiler water. The domestic and boiler water supplies did not contribute wastes to the sewers but they entered into the water economy program. The domestic supply came from wells, and the effluent from the sewage treatment plant drained into the untreated water supply line. The boiler water system obtained its raw water from one of the treated water supply lines.

The untreated water supply was obtained from irrigation canals, wells, and recirculated process water. It was used mainly in the blast furnace area for washing blast furnace gas and in the rolling mills for roll cooling and scale flushing. Untreated water was also used in the fire protection system.

The treated water supply was obtained from wells and surface streams. Most of the treated water was used for cooling purposes and was recirculated through a 1,000,000,000 gallon open reservoir which served as a cooling basin. Sulfuric acid was added to the water pumped from the reservoir to prevent scale deposition in the system.

Samples of treated and untreated water were taken during the period of the survey and analyzed for waste constituents so that net balances could be obtained for wastes contributed by plant operations.

The available water supplies were as follows:

Untreated water collection system	19.07 mgd
Treated water collection system	12.96
Domestic water supply wells	<u>1.01</u>
Total	33.04 mgd.

Water usage in the plant was as follows:

Untreated water	25.37 mgd
Treated water	215.5
Domestic water	.72
Boiler water	.50
Total	242.09

The water used in the plant and run to outfall sewers was as follows:

Untreated water supplies	19.06 mgd
Untreated water overflow	7.49
Untreated water actually used	11.57 mgd
Treated water	6.59
Total	18.16 mgd

Waste Lines

There were two outfall waste ditches leading from the plant to Utah Lake. The south sewer drained the wastes from a few auxiliary buildings in the southern part of the plant area, while the main outfall sewer drained the wastes from all the main operational units. The principal process waste lines discharging into the main outfall sewer were the blast furnace area drain, the rolling mill drain, the effluent from the benzol plant pond, and the overflow from the untreated water collection basin. Two settling-skimming ponds, operating in parallel, had been installed in the main outfall ditch.

Samples and flow measurements of the water-carried wastes were taken during the period of the survey for the purpose of determining the quantities of significant waste constituents discharged by the plant. The average daily flow through the main outfall sewer was 18,300 gpm (26.35 mgd) while the average daily flow through the south outfall sewer was 40 gpm (0.058 mgd).

The net quantities of significant waste constituents contributed by the operational units discharging water-carried wastes are as follows:

	Blast Furnace Area Drain lbs./day	Coke Plant Drain lbs./day	Rolling Mill Drain lbs./day
Suspended solids	5590		9870
Total iron (Fe)	4640		12000
Cyanides (CN)	59	0.81	
Sulfides (S)	52	.28	
Ammonia nitrogen (free)	150	3.6	
Phenols		45.	
Thiocyanates (NH_4SCN)	15		
B.O.D., 5-day	134		(*)
Oil	13		5650

* B.O.D. equipment was not available when the rolling mill survey was made.

The quantities and per cent removal of significant waste constituents by the skimming-settling ponds were as follows:

	Quantities Removed lbs./day	Per Cent Removal
Suspended solids	40,200	81.5
Total iron (Fe)	27,400	88.3
Cyanides (CN)	0	0
Oil	4,920	79.0
B.O.D., 5-day	560	27.0
Phenols	40	83.6
Ammonia nitrogen (free)	40	20.6

The net quantities of significant waste constituents discharged in the outfall sewers during the period of the survey were as follows:

	South Outfall Sewer lbs./day	Main * Outfall Sewer lbs./day	Total
Suspended solids	8.	2320.	2328.
Total iron (Fe)	2.47	3290.	3292.
Cyanides (CN)	0	21.5	21.5
Oil	0	1310.	1310.
B.O.D., 5-day	.14	631.	631.
Phenols	0	7.8	7.8
Ammonia nitrogen (free)	.77	155.	156.
Sulfides (S)		0	0
Thiocyanates (NH ₄ SCN)	0	0	0

* Effluent from twin settling basins.

GENERAL INFORMATION

1. Organization of Survey

A preliminary conference was held on March 6, 1951, between representatives of Geneva Steel Company (United States Steel Corporation subsidiary), the Utah State Department of Health, and the Public Health Service. The purpose of the meeting was to discuss the process wastes created by operations of the steel plant. An agreement was reached at another meeting on May 4, 1951, relative to the scope of a survey that might be undertaken.

After further correspondence, authority was granted to the Public Health Service to conduct a field survey in the Geneva Steel plant at Geneva, Utah.

2. Dates of Survey

May 21 to June 23, 1951.

3. Purpose of Survey

This survey was conducted to study the process wastes created by operations of the Geneva Steel plant, with particular reference to their sources, volumes, characteristics and methods of treatment. Information obtained will be useful in preparing an industrial waste guide for integrated steel plants.

4. Personnel Participating

Geneva Steel Company

L. J. Westhaver, Vice President and Manager of Operations
 R. C. Talbott, Chief Engineer
 W. C. Purvance, Asst. Chief Engineer
 R. G. Gaw, Power & Fuel Engineer
 Earl H. Pierce, Power & Fuel Engineer, A
 J. R. Gillespie, Power & Fuel Engineer, B
 W. C. Willard, Power & Fuel Engineer, C
 A. E. Terry, Superintendent, Coke Plant
 L. G. La Tronica, Asst. Supt., Coke Plant
 E. V. Boorman, Staff Asst. Technician
 G. J. W. Morlock, General Foreman, Coke Ovens
 A. L. Earl, Chief Chemist, Coke Plant
 G. R. Vest, Senior Chemist, Coke Plant
 D. J. Markman, General Foreman, By-Products and
 Benzol Plant Foreman
 W. Johnson, Benzol Plant Foreman
 M. J. Scott, Practice Man, Blast Furnace
 Ralph Seibel, General Foreman, Sintering Plant
 H. E. Tucker, General Foreman of Maintenance, Rolling Mill
 E. R. Clark, Lubrication Foreman, Plate and Slab Mill
 R. L. Gardiner, Lubrication Foreman, Structural Mill
 G. W. Madsen, Chief Chemist
 C. V. Rooney, Asst. Chief Chemist
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 Lynn Allenman, Sample Collector

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 D. M. Taylor, Public Health Engineer
 W. W. Walker, Sanitary Chemist
 G. E. Terhoeven, Sanitary Chemist
 C. N. Shadix, Sanitary Chemist
 C. R. Hirth, Physical Science Aide
 K. E. Beagle, Automotive Mechanic

5. Location of Plant

The Geneva Steel Plant is located at Geneva, Utah, approximately 35 miles south of Salt Lake City and some 6 miles north of Provo on the east shore of Utah Lake. The plant area is 1502 acres.

6. Employees

The number of employees was approximately 4600, which included office and technical staff.

7. Products

This is an integrated steel mill producing by-product coke, pig iron, and steel products.

8. Raw Materials

The principal raw materials used were iron ore, coal, pitch, limestone and dolomite.

9. Production

Three blast furnaces, with a rated capacity of 1160 tons pig iron per day each, were producing approximately 2720 tons per day. Steel ingot production averaged about 4000 tons daily while finished steel averaged about 3300 tons per day. The by-product coke plant carbonised approximately 5000 tons of coal per day. Daily coke by-product production per ton of charged material was as follows: 0.6641 ton coke, 11,513 cubic feet gas, 26.06 pounds ammonium sulfate, 10.67 gallons tar, 3.86 gallons light oil, and 0.056 gallon sodium phenolate.

10. Plant Operations

Operations of the blast furnaces, open-hearth furnaces and by-product coke plant were continuous. The slab and bloom department of the rolling mill operated seven days a week but the plate-strip and structural departments only operated five days a week. The plant operated on an 8-hour shift basis, with the day shift starting at 8:00 A.M.

11. Water Supply

The four main sources of water supply were Deer Creek, Provo River, company wells, and irrigation canal water from various sources. The total available water supplies were approximately 33 million gallons daily. Cooling water was recirculated through an open reservoir of 1,000,000,000 gallon capacity. A certain amount of process water from the blast furnace and rolling mill areas was also re-used. The total volume of water pumped daily was approximately 242 million gallons, whereas approximately only 18 million gallons were discharged daily to the sewers.

12. Waste Disposal

Process wastes discharged from the Geneva Works entered Utah Lake through two outlet ditches, the north outfall (main outfall) and the south outfall (contaminated water drain). The discharge from the north outfall averaged 18,300 gpm (26.35 mgd) and passed through two settling-skimming ponds operated in parallel. The average flow from the south outfall was 40 gpm (0.058 mgd).

13. Sanitary Sewage

All sanitary wastes, with the exception of those from the benzol plant, were discharged to a central disposal plant where they received relatively complete treatment. The treatment units consisted of a comminutor, primary clarigester, trickling rock filter with recirculation and combination chlorine-contact and settling tanks. The sludge from this final tank flowed by gravity to the west drainage ditch which discharged into the north drainage ditch. The chlorinated final effluent flowed to the untreated water collection basin and averaged about 221 gpm. The benzol plant sanitary wastes passed through a septic tank and the effluent was discharged into the benzol plant sewer, from which it flowed with process wastes to the north quench station.

14. Report Organization

This report is presented in five sections, as follows:

- A. Blast Furnace Operations and Wastes
- B. Coke Plant Operations and Wastes
- C. Rolling Mill Operations and Wastes
- D. Plant Water Use
- E. Waste Lines.

Sections A, B and C cover the operational processes, and characteristics, total quantities, quantities per unit of production, etc., of water-carried wastes originating from specific plant operations. Section D is an analysis of water use data for the various major plant operations. Section E covers the characteristics, quantities and methods of handling plant wastes discharged from general areas.

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SECTION A - BLAST FURNACE OPERATIONS AND WASTES

The major part of the hot metal produced by this department is used for steel production by the Geneva plant. Some pig iron is cast at infrequent intervals but this constitutes only a minor part of the total production. Water-carried wastes from blast furnace operations originate from the wet cleaning of the flue gases. Operations, survey procedures, wastes analyses, etc., are given below. A flow diagram is shown in Figure A-1.

DESCRIPTION OF PROCESS

1. Blast Furnaces

This plant is equipped with three blast furnaces and auxiliary equipment. They have a hearth diameter of 25 feet, a bosh diameter of 27 feet, 2 inches, a height of 93 feet, and a total volume of 36,500 $\frac{1}{2}$ cubic feet. Their rated capacity is 1160 tons pig iron per day; however, the average net production values at the time of the survey, for furnaces 1, 2 and 3, were 1036, 941 and 743 tons, respectively. Each furnace is equipped with its own auxiliary equipment, consisting of stoves, dry-dust catcher, wet gas washer and electrical precipitator.

Iron ore, manganese ore, roll scale, sinter, coke, dolomite, limestone and gravel are charged into the top of the furnace. The daily charges during the period of the survey are given in Table A-1. Normal practice is to crush all iron ore to at least 2-1/2" size at the mines.

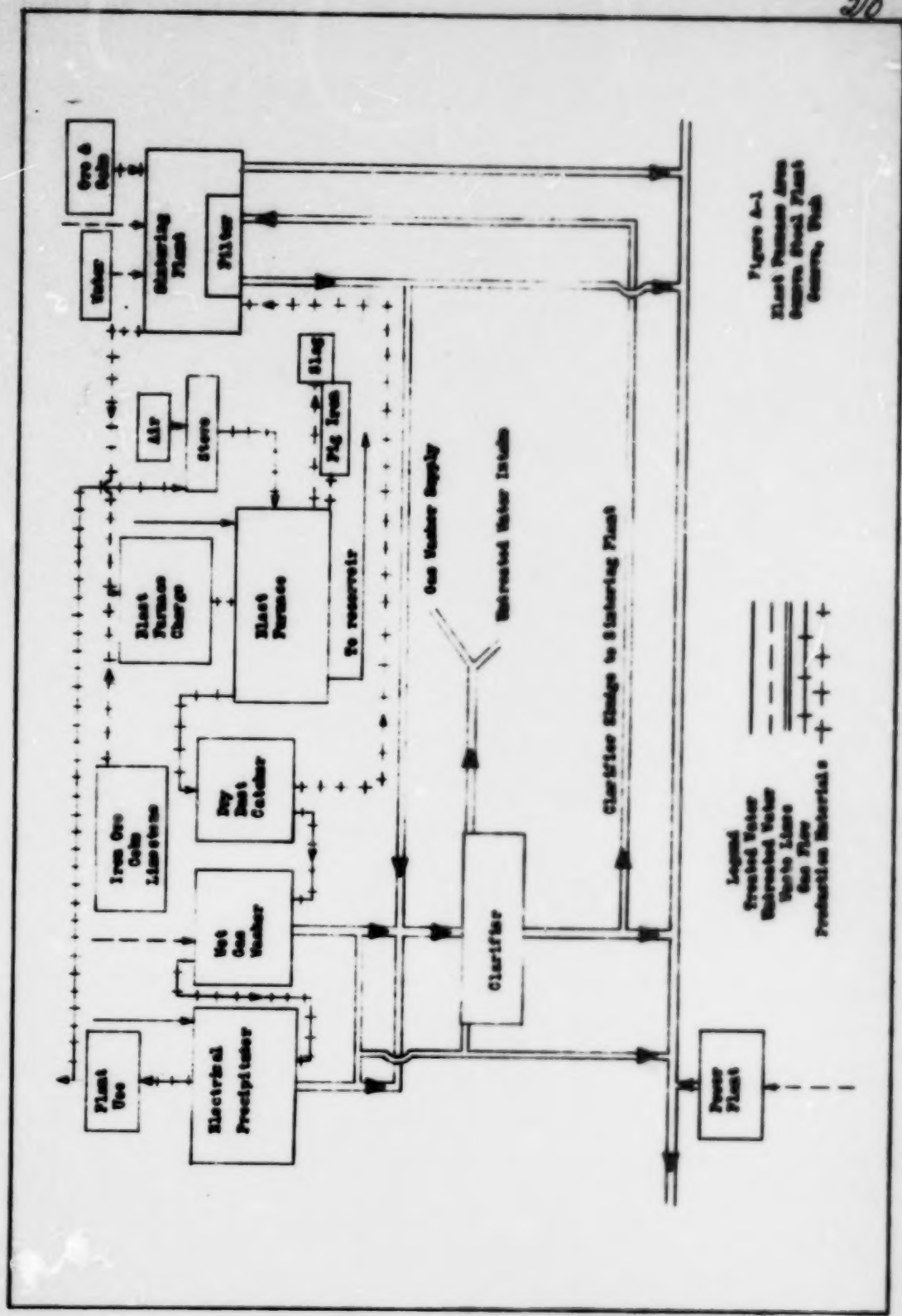


Figure A-1
Blast Furnace Area
Shows Steel Plant
Inputs, Flows

Ore is screened at Geneva to various sizes as desired by blast furnace management. At the time of the survey, ore was screened with 1.5" and 0.25" screens, thereby providing three ore sizes, namely: coarse (+1.5"), medium (-1.5" +0.25"), and fine (-0.25"). Most of the fine ore, which amounts to about 40 per cent of the total, is sintered for the purpose of improving the physical characteristics of the ore for blast furnace use.

Preheated air is blown into the furnace through openings (tuyeres) located near the bottom of the furnace, while slag and molten iron are drawn off at the bottom of the furnace. Operational data for the period of the survey are given in Table A-1.

2. Sintering Plant

There are two Dwight Lloyd sintering machines with a total capacity of 900,000 tons per year. These are down-draft sintering machines with a fan furnishing a draft of 175,000 cubic feet of air per minute (at 250°F and 28.45" S.P.) to each furnace. The average sinter charge consists of 90 per cent fine ore, 5 per cent coke breeze, 3.5 per cent flue dust (45 per cent iron), and 1.5 per cent filter cake (43 per cent iron on a dry basis). About 25 per cent of the sinter production is fed back to the sintering charge in order to produce the desired porosity in the sinter bed.

3. Stoves

Each furnace is equipped with three stoves for furnishing hot air blast. Normally, only one stove is on "blast" at a time, the other two being reheated or "bottled" for subsequent use. They are

equipped with an intricate checkerwork of refractory materials for retaining the heat supplied, cleaned blast furnace gas being used as a fuel. The cycle of heating and heat transfer to the air blast is repeated serially for the stoves.

4. Dry-Dust Catchers

The flue gas is led down from the top of the blast furnace through exhaust pipes (called downcomers) to a dry-dust catcher where the coarser particles are removed. The dust catcher is of the inertial or cyclone type and removes approximately 77 pounds of dust per ton of hot metal produced. Dry dust is removed periodically through a pug mill to a gondola car which carries it to the sintering plant or a stock pile.

5. Primary Wet Gas Washers

The blast furnace gas from the dry-dust catcher is passed through a wet washer countercurrent to sprays of water. There is intimate contact of the gas with the sprayed water, and the finer dust particles are removed with the descending water. A diagrammatic sketch is given in Figure A-2 of the gas washer designed by the Freyn Engineering Company of Chicago.

These cylindrical washers are approximately 90 feet high, with an inside diameter of 19 feet. The gas enters the washer near the bottom and passes up through three banks of horizontally suspended hurdles. Water is sprayed down into the washer through two sets of sprays and flows through the hurdles countercurrent to the gas. There is a water-seal in the conical bottom and the water flows out through a riser pipe from the bottom to a collection system. There is also an emergency gas release system (bleeder seal) on the side of the washer, which is a

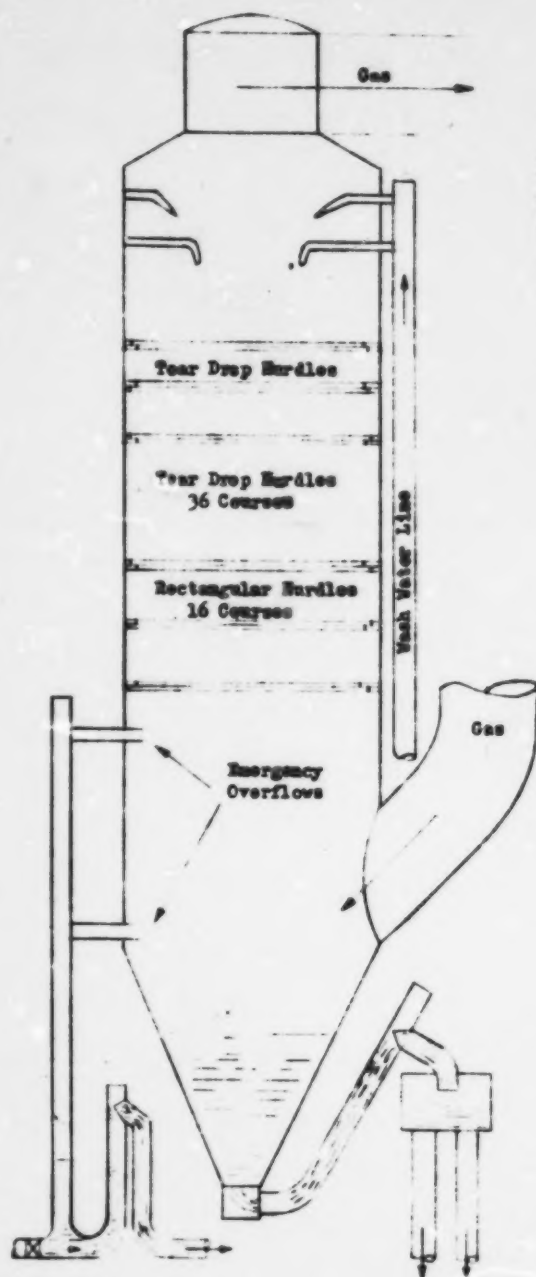


Diagram of Upper Spray Pipes



Diagram of Lower Spray Pipes

Figure A-2
Gas Washers
Geneva Steel Plant
Geneva, Utah

water-seal system supplied from a separate water line. The emergency seal provides an overflow for the water in the washer cone in the event the overflow line becomes plugged. Gases flow from the washer outlet to the precipitator inlets through a vertical main known as a "Hagen Bleeder Stack." A bleed valve is installed at the top of the vertical bleeder stack. Pressure in the entire gas system is controlled by automatic devices to open and close the Hagen valve to maintain desired gas main pressure.

6. Electrical Precipitators

The gas from the top of the wet washers is then passed through Cottrell electrical precipitators to remove the remaining fine particles of dust. It enters at the side of the unit, passes down around the tubes and then up through the tubes to the outlet. Water is introduced at the top header plate and flows down over the inside surface of the collecting tubes in a fine film. There is a weir ring at the top of each tube to distribute the water which continually flows down the tube. The top header plates and tubes were flushed three times a day at the time of the study, for 15 minutes, with a heavy stream of water. A sketch of this type of unit is shown in Figure A-3.

7. Dorr Clarifiers

The combined waste water discharge from the primary wet washers and electrical precipitators flows through a common header line to a wet well from which equal volumes are normally pumped to two Dorr clarifiers. At the time of the study, the clarifier supernatant was pumped in equal volumes to the primary gas washer feed line and the untreated

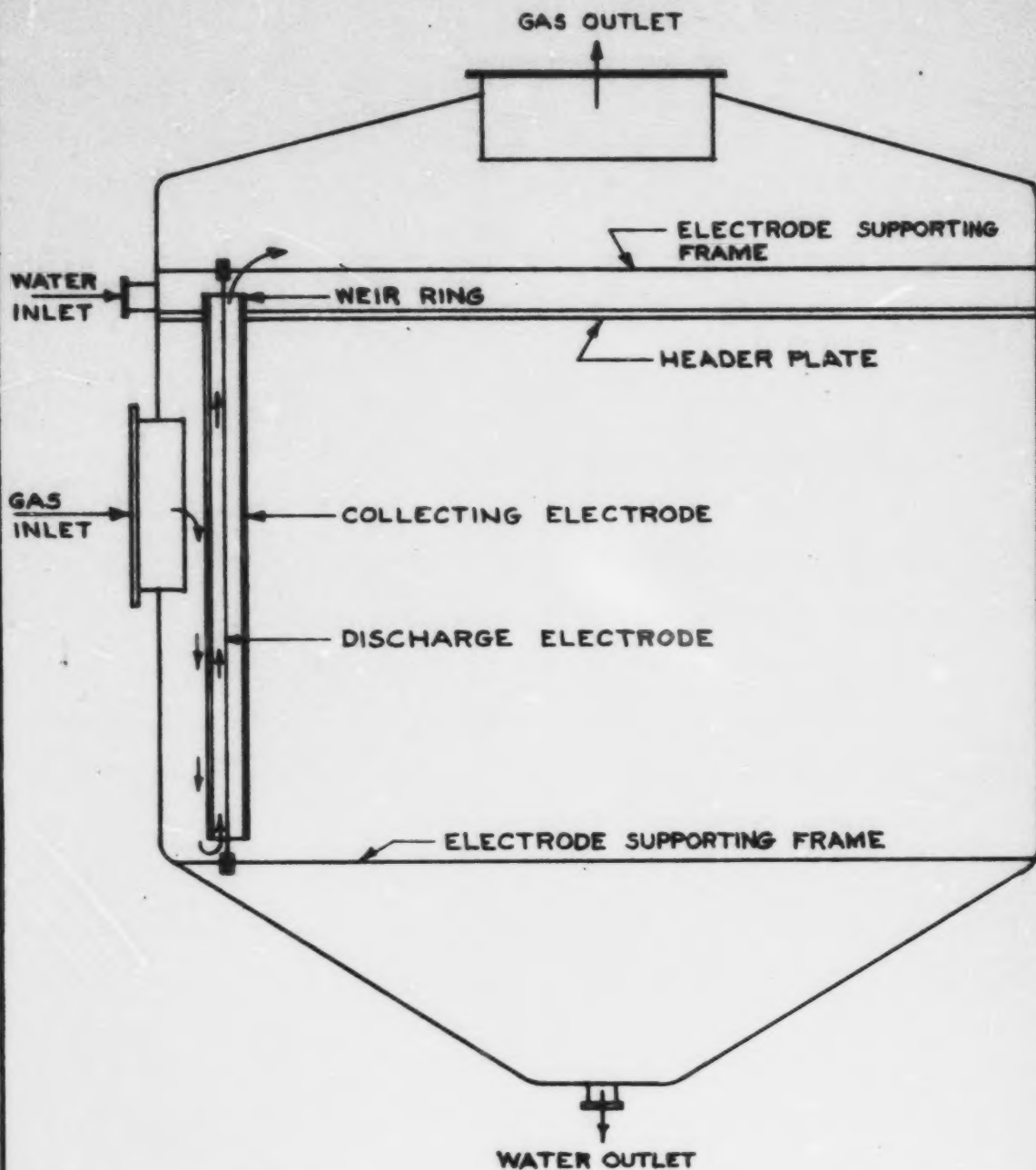


Figure A-3
Cottrell Electrical Precipitator
Genova Steel Plant
Genova, Utah

water intake line. The sludge from the bottom of the Dorr clarifiers is recirculated to the clarifier influents until the solids concentration is 25 per cent. It is then pumped to the Rimco disc filter in the sintering plant. The filter cake is used in the mix fed to the sinter machines and the filtrate flows back to the Dorr clarifier intake line.

The Dorr clarifiers are 110-foot diameter radial flow tanks with an average depth of 10 feet and a capacity of 600,000 gallons each. The flow through a unit is 4858 gpm and the detention time is approximately 2 hours, calculated on a fill-and-draw basis.

8. Clarifier Sludge Filter

Sludge from the clarifiers is filtered by an Rimco disc filter in the sintering plant. The sintering plant is shut down for one day a week in order to make repairs, and during part of this time all the sludge is diverted to the blast furnace area drain. Sludge is also by-passed to the drain when the filter is not functioning properly, although this is infrequent.

SURVEY PROCEDURES

9. Sample Collection

Samples were collected from the following points at the time of the survey:

- (1) Feed water (untreated) to the primary gas washers
- (2) Feed water (treated) to the electrical precipitators
- (3) Gas washer effluents (composite of 3 washers)
- (4) Precipitator effluents (composite of 3 precipitators)
- (5) Influent to Dorr clarifiers
- (6) Effluent from Dorr clarifiers
- (7) Blast furnace area drain.

Samples were collected at hourly intervals over 24-hour periods from 8:00 AM to 8:00 AM. Equal portions were taken and composited by two plant employees who worked on 12-hour shifts.

Separate samples were collected for the cyanide, phenol and sulfide determinations. The cyanide samples were preserved by adding pellets of sodium hydroxide to the sample bottles before sampling. The sulfide samples were preserved by adding approximately a gram of zinc acetate to gallon bottles before sampling. The phenol samples were preserved by adding approximately 4 grams of copper sulfate to gallon bottles before sampling.

10. Flow Data

All flow data, with the exception of that for the blast furnace area drain, were obtained from plant records. A 3-foot Parshall flume with level recorder furnished flow data for the blast furnace area drain.

11. Laboratory Analyses

The following laboratory determinations were made on samples collected in this department of the plant:

- (1) Total solids
- (2) Total volatile matter
- (3) Total suspended solids
- (4) Total volatile suspended matter
- (5) Iron
 - (a) Total
 - (b) Soluble
- (6) pH
- (7) Alkalinity
- (8) Cyanides
- (9) Phenols
- (10) Sulfides
- (11) Ammonia nitrogen.

The procedures followed in making these analyses were in general those given in "Standard Methods for the Examination of Water and Sewage," 9th edition. (1) The methylene blue method for sulfides was used. Special procedures for phenols, cyanides and iron were used and will be found in the appendix at the end of the report.

12. Explanation of Laboratory Analyses

A brief explanation of the various laboratory determinations is given in the appendix at the end of the report, and is intended to serve as an aid in the interpretation of the analytical results reported.

DISCUSSION OF RESULTS

Blast furnaces 2 and 3 were operating at reduced capacities but otherwise operations and wastes produced were normal during the period of the survey.

13. Operation and Production Data

Data were furnished by the Geneva Steel Company giving pertinent information concerning the operation of blast furnace units during the period of the survey. These data are given in Table A-1 in the appendix at the end of this section of the report. They contain such information as charges to furnaces, air blast, water use and production of pig iron, slag, gas, filter cake and dry dust.

The average daily production of pig iron for the period of the survey was 2782 tons.

The average daily quantities of materials produced per ton of hot metal were as follows:

<u>Gas</u>	<u>Flue Dust</u> <u>Dry Weight</u>	<u>Filter Cake</u> <u>Dry Dust</u> <u>Equivalent</u>	<u>Ladle Scrap</u>	<u>Other Scrap</u>
Cu. ft.	lbs.	lbs.	lbs.	lbs.
116,400	87	8.5	4.9	1

14. Water Consumption

Water consumption in the blast furnace units was fairly constant during the period of the survey. Average consumption figures are shown below:

	Average Daily Use M.G.	Gal/Ton Hot Metal	Gal/1000 Cu.Ft. Gas
Furnace cooling*	23.859	8,576	73.7
Gas washing	10.980	3,946	33.9
Electrical precipitators	2.192	738	6.7
Total	37.031	13,310	114.3

* Returned to treated water reservoir and not run to waste.

15. Waste Characteristics

The analyses of samples taken during the period of the survey are given in Table A-2 in the appendix at the end of this section of the report. The average concentrations of significant waste constituents in the gas washer and precipitator effluents are as follows:

	Suspended Solids ppm	Total Iron (Fe) ppm	Cyanide (CN) ppm
Primary gas washers	837	547	1.58
Electrical precipitators	83	14.8	.3

16. Waste Quantities

The quantities of waste constituents in the effluents from the gas washers and electrical precipitators are given in Table A-3.

The average daily quantities of significant waste constituents in the gas washer and electrical precipitator effluents are as follows:

	Suspended Solids lbs./day	Total Iron (Fe) lbs./day	% Iron in Sus- pended Solids	Cyanide (CN) lbs./day
Gas washers	76,100	49,700	65.3	143
Electrical precipitators	1,510	269	17.8	5.45

17. Waste Quantities Removed from Gas

The quantities of significant waste constituents removed from the gas in the washers and precipitators are given in Table A-4.

The average daily quantities are as follows:

	Suspended Solids lbs./day	Total Iron (Fe) lbs./day	% Iron in Suspended Solids	Cyanides (CN) lbs./day
Gas washers	71,500	47,700	65.7	132
Electrical precipitators	1,230	263	21.4	5.45
Total	72,730	47,963		137.45

18. Clarifier Operation

During this survey, laboratory analyses were made on samples of the Dorr clarifier influent and effluent primarily for the purpose of determining the efficiency of this type of unit in treating this type of waste. These units are essentially settling tanks for the removal of suspended solids, and their efficiency is based on percentage removals of suspended materials. The theoretical detention period, calculated on a fill-and-draw basis, was approximately 2 hours.

(a) Waste Characteristics - The analyses of samples taken during the period of the survey are shown in Table A-2. The average concentrations of significant waste constituents are as follows:

	<u>Influent</u> <u>ppm</u>	<u>Effluent</u> <u>ppm</u>	<u>Removal</u> <u>ppm</u>
Total suspended solids	660	64	596
Total iron (Fe)	397	45	352
Cyanides (CN)	1.4	1.45	0
Sulfides (S)	1.59	.4	1.19

(b) Waste Quantities - The daily quantities of waste constituents removed from the gas washing water are given in Table A-4. The average concentrations of significant waste constituents are as follows:

	<u>Influent</u> <u>lbs./day</u>	<u>Effluent</u> <u>lbs./day</u>	<u>Removal</u> <u>lbs./day</u>
Total suspended solids	72,100	6,990	65,110
Total iron (Fe)	43,400	4,930	38,470
Cyanides (CN)	150	158	0
Sulfides (S)	174	43.8	130

On the basis of removals, 59.1 per cent of the suspended solids removed by the clarifiers is iron.

19. Blast Furnace Area Drain (See Item 7 (2), page 124)

The analyses of samples and the quantities of waste constituents are given in Tables A-2 and A-3. The average concentrations and daily quantities of significant waste constituents are as follows:

	Concen- trations ppm	Gross Quantities ppm	Contributed by Water Supplies lbs./day	Net Quantities lbs./day
Total suspended solids	99.	8300	2710	5590
Total iron (Fe)	57.	4770	129	4641
Cyanides (CN)	.70	59	0	59
Sulfides (S)	.60	52	0	52
Ammonia nitrogen (free)	1.7	150	0	150

SUMMARY

Pertinent data summarizing the results of the blast furnace area are shown below:

Unit Blast Furnace Values per Ton of Hot Metal Produced

	Wash	W a s t e s		
	Water gals.	Suspended Solids lbs.	Total Iron (Fe) lbs.	Cyanide (CN) lbs.
Gas washers	3946	25.7	17.1	0.047
Electrical precipitators	788	.44	.095	.002
Total	4734	26.14	17.195	0.049

Unit Blast Furnace Values per Million Cubic Feet Gas Cleaned

	Wash Water gals.	W a s t e s		
		Suspended Solids lbs.	Total Iron (Fe) lbs.	Cyanide (CN) lbs.
Gas washers	33.9	221.	147.	0.406
Electrical precipitators	<u>6.7</u>	<u>3.8</u>	<u>.81</u>	<u>.017</u>
Total	40.6	224.8	147.81	0.423

The efficiency of the Dorr clarifiers is summarized as follows:

	<u>Per Cent Removal</u>
Total suspended solids	90.3
Total iron (Fe)	88.6
Cyanides (CN)	0
Sulfides (S)	74.8

The average daily net and unit quantities of significant waste constituents discharged from the blast furnace area are as follows:

	<u>Net Quantities</u>	<u>Quantities per Ton Hot Metal</u>
Suspended solids	5590 lbs./day	2.01 lbs.
Total iron (Fe)	4640 "	1.67 "
Cyanides (CN)	59 "	.0212 "
Sulfides (S)	52 "	.0187 "

Blast Furnace Area
Genova Steel Plant
Genova, Utah

**Table A-1 - Blast Furnace Operation
 and Production**

Charge to Blast Furnaces - Net Tons

Date 1951	Coarse Ore(a)	Medium Ore(b)	Sinter (c)	Manga- nese Ore	Roll Scale	Coke	Dolo- mite	Lime- stone	Gravel
May 22-23	954	1800	2019	19.7	152	2331	257	441	48
May 23-24	973	1693	2057	20.0	149	2300	234	438	31
May 27-28	1064	1522	2331	11.0	148	2285	237	435	54
May 30-31	1018	1886	1936	12.3	148	2257	259	501	17
Average	1002	1725	2085	15.7	149	2293	246	453	37
Average, May, 1951	1324	1395	2004	16.0	162	2258	253	449	29
(a) 1.5" $\pm$ (b) -1.5" $\pm$ 1/4" (c) -1/4" ore used for sinter									

Blast Furnace Operations

Date 1951	Blast (a)				Water Used		
	Air(b) cu.ft/ min.	Blast Temp. °F.	Top Temp. °F.	Pressure Inches Mercury	Furnace Cooling mgd(c)	Gas Washings mgd.	Electrical Precipitators mgd.
May 22-23	52,054	1147	367	19.56	23.367	11.088	2.1915
May 23-24	52,151	1116	359	19.65	23.540	10.944	2.1915
May 27-28	52,167	1137	339	20.14	24.028	10.944	2.1915
May 30-31	52,943	1052	337	19.46	24.504	10.944	2.1915
Average	52,321	1113	350	19.70	23.859	10.980	2.1915
Average, May, 1951	52,487	1103	358	18.63			2.1915
(a) Average figures for 3 furnaces. (b) Standard conditions. (c) Treated water - returned to treated water reservoir.							

Blast Furnace Production

Date 1951	Pig Iron Net Tons	Gas M.C.F.	Flue Dust	Filter Cake	Ladle	Other
			Dry Weight	Dry Dust Equiv.	Scrap	Scrap
			pounds per net ton of iron			
May 22-23	2819	331.4	79	8.6	5	1
May 23-24	2853	324.9	112	3.4	5	1
May 27-28	2878	320.0	70	8.0	5	1
May 30-31	2567	319.0	87	9.0	4.7	1
Average	2782	323.8	87	8.5	4.9	1
Average-May	2720		77	9.0	4.0	4

Blast Furnace Dept.
 Geneva Steel Plant
 Geneva, Utah

Table A-2 - Summary of Analyses of Samples
 (Results in parts per million)

1951 May	Sam- ple No.	Tot. Solids		Susp. Solids		Iron		Alka- lin- ity	pH	Cya- nide (CN)	Pho- sol	BOD 5- day	Sul- fide (S)	Ammo. Nitro- gen
		Total	Vola- tile	Total	Vola- tile	Total	Dis- sol.							
		Water to Gas Washer												
22-23	B3			59	11	31.5			8.3	0.4				
23-24	B13	456	134	46	24	13.		238	7.4	0				
27-28	B33	480	94	61	16	26.		226	7.9	0.1				
30-31	B63	453	84	37	6	17.		229	7.8	0	0			
Avg.		463	104	50.8	14.3	21.9		231	7.8- 8.3	0.13	0			
		Gas Washer Effluent												
22-23	B4	808	164	516	176	201			7.9	1.4				
23-24	B14	1398	168	912	164	642		277	7.1	1.5				
27-28	B34	1024	172	528	54	466		282	7.1	1.9				
30-31	B64	1848	228	1390	132	878		418	7.6	1.5				
Avg.		1270	183	837	132	547		326	7.1- 7.9	1.58				
		Precipitator Water Supply												
22-23	B2	374	94	13	9	0.25			8.3	0	0	12.1	0	
23-24	B12	364	78	18	14	1.1		130	8.	0		10.8		0
27-28	B32	380	86	21	13	0		135	8.3	0	0	11.0		0
30-31	B62	384	88	10	10	0		138	8.3	0	0	9.0		
Avg.		376	87	15.5	11.5	0.34		134	8.0- 8.3	0	0	10.7	0	0
		Precipitator Effluent												
22-23	B5	550	110	104	16	18.5			7.7	0.3				
23-24	B15	212	204	74	22	13.7		177	7.5	0.3				
27-28	B35	504	108	87	22	13.4		184	6.9	0.5				
30-31	B65	538	82	67	21	13.5		186	6.9	0.1				
Avg.		451	126	83	20.3	14.8		182	6.9- 7.7	0.3				
		Dorr Clarifier Influent												
22-23	B6	1022	228	472	8	380	0		7.9	1.3	1.68		1.67	
23-24	B16	1282	238	948	52	564		260	7.5	1.1	0.26			
27-28	B36	854	140	466	78	268	0	284	7.7	1.9	0.55		1.5	
29-30	B56	840	138	382	46	216	0	242	7.4					
30-31	B66	1398	60	1034	322	558	0	368	7.7	1.2	0.4			
Avg.		1079	161	660	101	397	0	289	7.4- 7.9	1.4	0.72		1.59	
		Dorr Clarifier Effluent												
22-23	B7	546	148	58	12	34.5	0		8.0	1.5			0.4	
23-24	B17	528	168	82	16	48.5		258	7.6	1.7				
27-28	B37	534	64	71	10	45.8	0	255	7.8	1.5			0.4	
29-30	B57	520	86	45	10	44.	0	238	7.8					
30-31	B67	532	76	64	11	53.	0	255	7.8	1.1				
Avg.		532	108	64	11.8	45.2	0	252	7.6- 8.0	1.45			0.4	
		Blast Furnace Area Drain												
22-23	B8	564	114	109	15	51			8.0	0.6			0.6	
23-24	B18	724	154	322	60	205		240	7.6	0.9				1.8
27-28	B38	526	96	107	10	67		236	7.7	1.0	0		0.6	1.9
30-31	B68	508	74	83	16	53		232	7.7	0.5	.024			1.6
Avg.		532	94	99	13	57		234	7.7- 8.0	0.70	.012		0.6	1.7

* Not used for averages because all flow was deliberately
 diverted this day for flow-measuring purposes.

Blast Furnace Dept.
Geneva Steel Plant
Geneva, Utah

Table A-3 - Quantities of Waste Constituents
(Pounds)

1951 May:		Sample No.	Total Solids		Susp. Solids		Iron		Alka- lin- ity	Cya- nide (CN)	Phenol	BOD 5- day	Sul- fide (S)	Am- monia Nit- rogen	Flow MGD
			Total	Vola- tile	Total	Vola- tile	Total	Dis- sol.							
			Water to Gas Washer Effluent												
22-23	B3				5430	1012	2899			36.8					11.088
23-24	B13	41421	12172		4178	2180	1181		21619	0					10.944
27-28	B33	43601	8539		5541	1453	2362		20529	9.1					10.944
30-31	B63	41239	7630		3361	545	1544		20801	0	0				10.944
Avg.			42087	9447	4627	1297	1996		20983	11.4	0				10.980
			Gas Washer Effluent												
22-23	B4	74361	15093		47488	16197	18498			129					11.088
23-24	B14	126988	15260		82842	14897	58316		25161	136					10.944
27-28	B34	93015	15624		47961	4905	42329		25616	173					10.944
30-31	B64	167863	20710		126261	11990	79753		37969	136					10.944
Avg.			115556	16671	76138	11997	49724		29582	143					10.980
			Precipitator Water Supply												
22-23	B2	6803	1710		236	164	4.5			0	0	229	0		2.1915
23-24	B12	6621	1419		327	255	20.		2360	0		196		0	2.1915
27-28	B32	6912	1564		382	236	0		2456	0	0	200		0	2.1915
30-31	B62	6985	1601		182	182	0		2510	0	0	164		0	2.1915
Avg.			6830	1573	282	209	6.1		2442	0	0	195	0	0	2.1915
			Precipitator Effluent												
22-23	B5	10004	2001		1892	291	237			5.46					2.1915
23-24	B15	3856	3711		1346	400	249		3220	5.46					2.1915
27-28	B35	9168	1964		1583	400	244		3347	9.09					2.1915
30-31	B65	9786	1492		1218	382	246		3383	1.82					2.1915
Avg.			8203	2292	1510	368	269		3316	5.45					2.1915
			Dorr Clarifier Influent												
22-23	B6	112645	25130		52024	382	41880	0		143	185		184		13.2795
23-24	B16	139770	25948		103356	5669	61490		28347	120	28				13.1355
27-28	B36	93107	15264		50806	3504	29219	0	30963	207	60		164		13.1355
29-30	B56	91581	15045		41648	5015	23549	0	26384						13.1355
30-31	B66	152417	6542		112732	35106	60836	0	40121	131	44				13.1355
Avg.			117904	17585	72113	11035	43394	0	31453	150	79		174		13.164
			Dorr Clarifier Effluent												
22-23	B7	60180	16313		6393	1323	3803	0		165			44.1		13.2795
23-24	B17	57565	18316		8940	1744	5288		28128	135					13.1355
27-28	B37	58219	6978		7741	1090	4993	0	27801	164			43.6		13.1355
29-30	B57	56693	9376		4906	1090	4797	0	25948						13.1355
30-31	B67	58001	8286		6978	1199	5778	0	27801	120					13.1355
Avg.			58131	11853	6991	1239	4931	0	27419	158			43.8		13.164
			Blast Furnace Area Drain												
22-23	B8	45080	9112		8712	1199	4076			43			48.		9.63
23-24	B18*	85932	18278		38218	7121	24331		28846	107				214	14.3*
27-28	B38	48897	8924		9947	930	6247		21939	93	0		55.8	177	11.2
30-31	B68	38158	5559		6235	1202	3981		17427	38	1.8			120	9.05
Avg.			44045	7865	8298	1110	4768		19683	59	0.9		51.9	170	9.96

* Not figured in average because all flow was deliberately diverted this day to the drain for flow-measuring purposes.

Blast Furnace Dept.
Geneva Steel Plant
Geneva, Utah

Table A-4 - Quantities of Significant Waste
Constituents Removed from Gas

Date 1951 May	Suspended Solids			Iron (Fe)				Cyanides (CN)		
	In Water Supply lbs.	In Efflu- ent lbs.	Removed from Gas lbs.	In Water Supply lbs.	In Efflu- ent lbs.	Removed from Gas lbs.	% Iron in Sus- pended Solids	In Water Supply lbs.	In Efflu- ent lbs.	Removed from Gas lbs.
Primary Gas Washers										
22-23	5,430	47,488	42,058	2,899	18,498	15,599	37.1	36.8	129	92.2
23-24	4,178	82,842	78,664	1,181	58,316	57,135	72.6	0	136	136.
27-28	5,541	47,961	42,420	2,362	42,329	39,967	94.2	9.1	173	163.9
30-31	3,361	126,261	122,900	1,544	79,753	78,209	63.6	0	136	136.
Avg.	4,627	76,138	71,511	1,996	49,724	47,728	66.7	11.4	143	131.6
Electrical Precipitators										
22-23	236	1,892	1,656	4.5	337	332.5	20.1	0	5.46	5.46
23-24	327	1,346	1,019	20.	249	229.	22.4	0	5.46	5.46
27-28	382	1,583	1,201	0	244	244.	20.3	0	9.09	9.09
30-31	182	1,218	1,036	0	246	246.	23.7	0	1.82	1.82
Avg.	282	1,510	1,228	6.1	269	262.9	21.4	0	5.45	5.45

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SECTION B - COKE PLANT OPERATIONS

Mixtures of coal are carbonised under carefully controlled conditions in ovens, to produce metallurgical coke and coke by-products. Practically all of the coke is used in the blast furnaces, the coke oven gas is burned for heating purposes, and the other by-products are sold as commercial products. In addition to coke oven gas, the by-products are ammonium sulfate, sodium phenolate, tar, and light oil. The light oil is refined in the benzol plant for production of benzol, toluol, xylol, solvent naphtha, and naphthalene.

DISCUSSION OF PROCESS

The coke plant is divided into three general areas and will be discussed under the following headings:

- I. Coking Area
- II. By-Product Area
- III. Benzol Area

I. Coking Area

1. Carbonization

The coking plant operates 252 Koppers coke ovens, arranged in four batteries of 63 ovens each. These ovens are of the Becker underjet type, being 13 inches wide at the pusher side and 15-1/2 inches wide at the coke side; 3 feet 7-1/2 inches from center to

center of ovens; 13 feet high from oven floor to oven roof, and 28 feet 9-3/8 inches high from top of pad to top of battery; 40 feet 5-1/2 inches long inside of oven door lining. The capacity per oven is 14.4 net tons of charge. Gas for heating is distributed through pipes installed in the basement afforded by the design. In the pipe to each flue, a regulating orifice is installed and gas is proportioned to each flue by changing the size of the orifice. Gas is metered to each vertical flue at constant temperature and pressure, and gas supply, draft and air supply are carefully co-ordinated. The gases from four to six vertical heating flues in the oven walls are gathered into a short horizontal flue and led through a crossover flue of inverted U-shape to the top of every other oven and down through four to six vertical flues on the other side. Thus, each set of four to six vertical flues is separated from each other set. There may be five to eight of these sets across the length of the oven. This flow is reversed regularly.

The pulverized coal mixture used for charging the ovens is delivered to elevated storage bins serving all of the ovens. The bulk of the coal carbonized comes from Carbon County, Utah, and is high-volatile coal, referred to as Horse Canyon Coal from the Sunnyside Seam, Columbia Mine. Low-volatile coal comes from the Oklahoma-Arkansas coal fields. The oven charge is a mixture of 82 per cent high-volatile coal, 14 per cent low-volatile coal, and 4 per cent pitch. Oil at the rate of one quart per ton is also added to the charge mixture. The average coal blend for 1950 was reported as follows:

Volatile	35.4 per cent
Fixed carbon	57.0
Ash	7.6
Sulfur	.95
Moisture	4.5

Two of the coke oven batteries are fired with coke oven gas, while the other two are fired with cleaned blast furnace gas. Approximately 21 per cent of the coke oven gas produced is used for carbonization. Gas is fired to the ovens at the rate of approximately 1287 B.T.U. per pound of coal.

The rated gross coking time is 18 hours and averaged 17 hours during the period of this survey. The average flue temperature was reported as 2325°F., while the oven wall temperatures as determined by an optical pyrometer were reported as: bottom 2150°F., center 2220°F., and top 2230°F. These temperatures were stated to approach the maximum for coking this type of coal without damaging the ovens.

2. Coke Quenching and Handling

When carbonization is complete, the incandescent coke is pushed out of the oven with a ram, operated by a mechanical pusher, through a coke guide on the opposite end of the oven and into the quenching car. The quenching car is then run to one of two quenching stations and, after quenching, run to a dumping wharf from which the coke is transferred to a screening station for processing.

Coke plant waste liquors, plus enough treated water to maintain quenching requirements, are used in the two quenching stations. Ammonia still wastes are used in the south quench station and benzol plant wastes

plus final cooling water from the by-product plant in the north quench station. Water levels in the quench water pits are maintained by float valves operating on the treated water lines. Just enough water is used, to quench the coke without leaving it wet. About 2650 gallons are used per quench, and there is approximately a 55 per cent loss due to evaporation and retention in the coke (3.0 - 3.5 per cent). The drain water from the quench stations is run back to the quench pits and re-used. There are no apparent damaging effects due to the use of waste liquors for quenching. Low relative humidity and the prevailing winds may be factors in the corrosion picture. Coke breeze is periodically removed from the quench pits.

3. Gas Collection

Volatile materials, produced during the coking period, leave the ovens through refractory-lined ascension pipes and pass into the collecting main through liquor-sealed valves. These distillation products consist mainly of various hydrocarbons: fixed gases, liquids at ordinary temperatures, and solids at ordinary temperatures. Take-off mains connect the collecting mains to the exhaust main. Maintenance of a uniform pressure on the ovens and in the collecting main is accomplished by a pressure regulator operating a butterfly valve in the off-take main. A similar governor on the exhauster maintains constant negative pressure in the suction main.

Ammonia liquor sprays at the valves and in the collecting main reduce the gas temperature from about 1100°F. (600°C.) to approximately 200°F. (93°C.). The condensed tar and moisture are washed out

of the collecting main by the flushing liquor and flow through a downcomer and into three flushing liquor decanters which are operated in parallel. The tar is pumped to storage tanks and the weak ammonia liquor recycled to the collecting mains. Surplus liquor is pumped to an ammonia liquor storage tank.

II. By-Product Area

The process flow diagram for the by-product area is shown in Figure B-1.

4. Primary Coolers

Gas from the collecting mains is drawn through the exhaust main to primary coolers where it is cooled from a temperature of approximately 176°F. (80°C.) to 93°F. (34°C.). Three coolers are operated in parallel, only two being in operation at the same time. These coolers are of the direct type, with the gas being drawn up through the cylindrical towers containing wooden grids. Cool ammonia liquor flows down over the grids countercurrent to the gas and: (1) cools the gas, and (2) removes ammonia, tar and suspended solids from the gas. About 85 per cent of the tar is condensed out of the gas in the mains and another 10 per cent in the primary coolers.

Ammonia liquor and tar are pumped from the bottom of the coolers to a decanter. Tar from this decanter is pumped to the three tar decanters connected to the collecting mains, and the ammonia liquor is

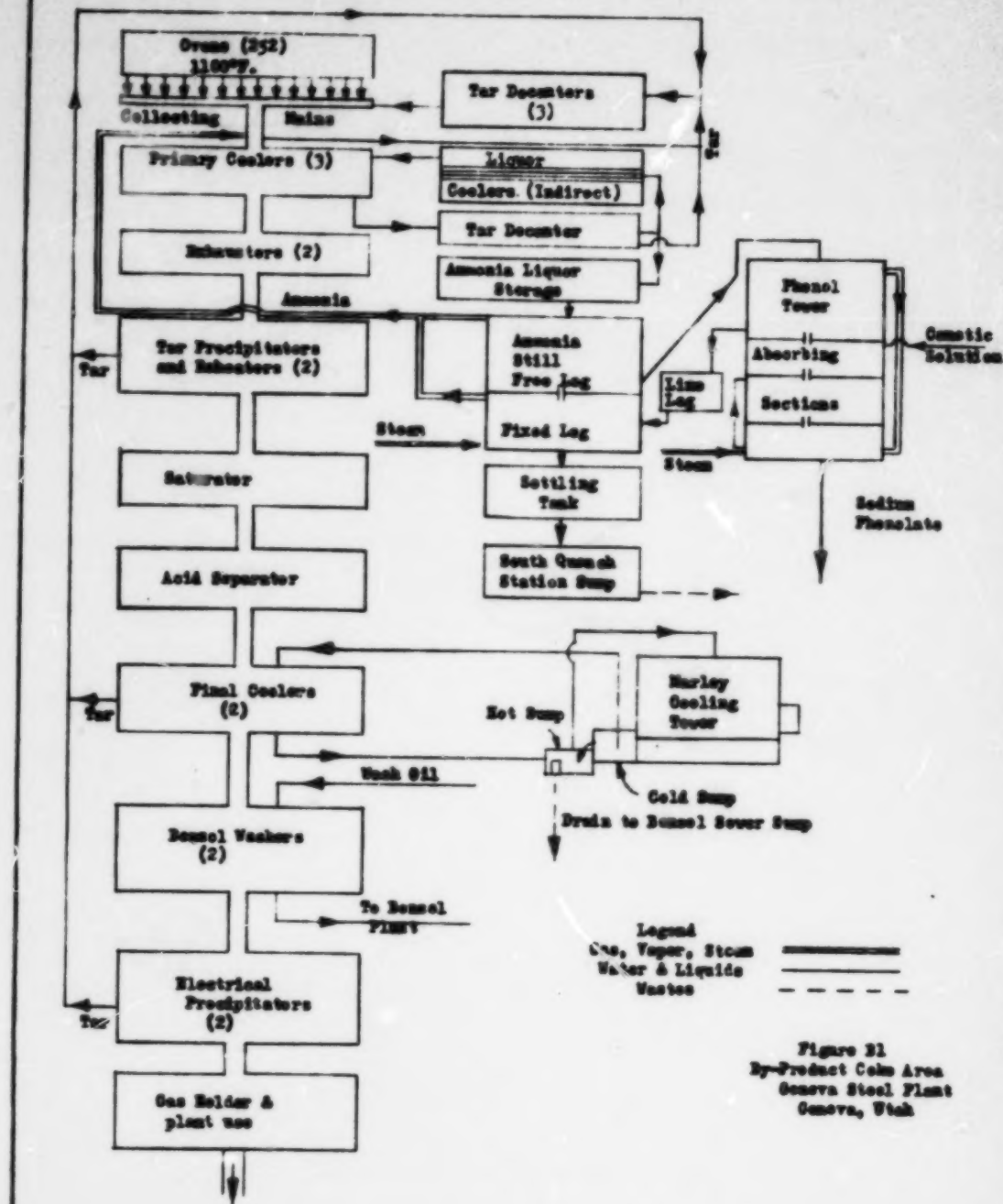


Figure 21
 By-Product Coke Area
 Geneva Steel Plant
 Geneva, Utah

pumped through a series of tubular water coolers of the indirect type. The excess liquor, over and above that recirculated to the primary coolers, is pumped to a storage tank.

5. Ammonia Recovery

Surplus ammonia liquor is pumped from a storage tank to the ammonia still where ammonia is removed by steam distillation. The ammonia still is a cast iron tower containing bubble trays and is divided horizontally into two sections, the free leg and the fixed leg. The ammonia liquor first enters the top or free leg where the free ammonia is removed by steam from the top of the fixed leg. The liquor from the free leg is then pumped to the top of the Koppers dephenolizing tower where the phenol is removed (dephenolizing process will be discussed in next item). After dephenolization, the ammonia liquor is then run into a lime leg where slaked lime is added (4000 lbs. per day). The limed liquor then runs back into the bottom (fixed) leg of the ammonia still where the fixed ammonia (combined as ammonium salts) is removed. Low-pressure steam is added directly to the fixed leg and the excess rises through the top of the fixed leg through bubblers to the free leg. Ammonia gas from the free and fixed legs is led back to the gas stream ahead of the primary coolers.

Water added to the ammonia still in the form of steam and slaked lime amounted to 28 per cent of the original volume of liquor. It was assumed that 14 per cent was added in each leg of the still.

The waste ammonia liquor from the still is run through a settling tank to the south quenching tower pit.

6. Phenol Recovery

Phenol is recovered from the ammonia liquor by means of a Koppers vapor recirculation tower. The ammonia liquor from the bottom of the free leg of the ammonia still is sprayed into the top section of the phenol recovery tower. Phenol is removed by steam flowing countercurrently up through wooden hurdles. The dephenolized liquor then flows down by gravity from the bottom of the dephenolizing section of the tower to the lime section of the ammonia still.

The three bottom sections of the phenol tower are absorbing sections where phenol is removed as sodium phenolate. The phenol-enriched steam is recirculated from the top to the bottom of the tower and then passes up through the two lower sections which contain steel turnings and in which sodium phenolate, containing free caustic, is recirculated. The top absorption section is packed with steel turnings which are kept wet with a fresh solution of 10 per cent sodium hydroxide, pumped by a soda "shot" pump, working in connection with a timer from a mixing tank. This top section absorbs the last traces of phenol before the steam enters the top dephenolizing section. The caustic solution progressively overflows to a lower section and is recirculated until the sodium phenolate concentration builds up to the required value for sale.

7. Exhausters, Precipitators and Reheaters

The exhausters draw the gas from the ovens and primary coolers and force it through the succeeding units to the gas holder. These exhausters are steam turbine-driven units in which the centrifugal force

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removes additional tar from the gas. The temperature of the gas from the primary coolers is raised from approximately 93°F. (34°C.) to 113°F. (45°C.).

Gas from the exhausters then passes through electrical precipitators where more tar is removed on passing through a strong electrical field produced by a high potential difference between electrodes.

Tar removed in the exhausters and precipitators is flushed through seals to the decanters operating in series with the gas-collecting mains.

The gas next flows through reheaters where its temperature is raised to approximately 129°F. (54°C.).

5. Saturators and Ammonia Recovery

The gas from the reheaters passes through a saturator where ammonia is removed in the form of ammonium sulfate. It bubbles up through a weak sulfuric acid solution in a steel lead-lined cylindrical tank with a cone-shaped bottom. The ammonium sulfate crystals settle to the bottom and are removed continuously as a slurry to a centrifuge where they are removed from the mother liquor. The ammonium sulfate is then dried, discharged to storage and finally sold. The acid liquor separated in the centrifuge is returned to the saturator.

Concentrated sulfuric acid (66°Be) is added to the saturator until the concentration reaches 13 per cent. The concentration is allowed to drop to 4 per cent and held at 4 per cent for about 4 hours. At the end of this 4-hour period, more concentrated acid is added until the concentration again reaches 13 per cent. The process is continually repeated in this manner. One pound of sulfuric acid produces about 1.2 pounds of ammonium sulfate.

tar separating out in the saturator floats on the surface of the acid solution. It is withdrawn to an overflow tank where it is skimmed off and discarded to the dump. The acid is returned to the saturator.

9. Acid Separator

Gas from the saturator passes through an acid separator where entrained acid is removed by cyclonic action. Reclaimed acid is returned to the saturator.

10. Final Coolers

Gas from the acid separator is passed through a final cooler where it flows up through wash water falling down over wooden grids. There are two coolers which are used alternately. The gas temperature drops from about 136°F. (58°C.) to 93°F. (34°C.). Naphthalene is removed from the cooling water in an absorber section at the base of the cooler. Tar is circulated through this section in direct contact with the cooling water to effect removal of naphthalene. Water-soluble substances, such as cyanides, sulfides and phenols, are removed from the gas by the cooling water which is recirculated through a Marley cooling tower.

11. Marley Cooling Tower

The final cooling water is cooled by being pumped from a hot sump to the top of the wooden Marley tower and allowed to cascade down over wooden hurdles in the tower. Air is blown into the base of the tower by large fans and passed up through the tower countercurrent to the falling water. The cooled water from the base of the tower flows

to a cold sump from which it is pumped to the top of the final cooler. Approximately three times as much water is pumped through the Marley tower as through the final cooler, so the difference flows directly to the hot sump from the cold sump.

The Marley tower is inadequate in size to cool the water sufficiently, and treated water is fed periodically into the cold sump to make up for cooling tower evaporating losses and supply additional water for quenching when other wastes are not sufficient to meet quenching demands. The cap on a standpipe in the hot sump is raised and hot water runs out of the sump until the water level reaches the top of the standpipe. This waste cooling water runs to a sump supplying quench water for the north quench station.

12. Benzol Washers

Gas from the final coolers is passed through two benzol washers in parallel where the light oils are removed by counterflow scrubbing with wash oil. The wash oil is a high-boiling-point paraffin oil and dissolves the light oils from the gas as it flows down over wooden hurdles. The light oils are removed from the wash oil in the light oil recovery system and the debenzolized wash oil is recycled to the benzol washers for further light oil recovery.

The temperature of the gas and oil leaving the benzol washers is 91°F. (33°C.). The flow of wash oil averages about 185 gallons per ton of coal carbonized.

13. Final Precipitators

The gas from the benzol washers passes through two electrical precipitators operating in parallel. Final traces of tar are removed and pumped to the tar decanters. The gas then passes to the gas holder for plant use.

III. Benzol Area

For the purpose of this discussion, the benzol plant will be considered as consisting of two distinct units:

- (a) Light oil recovery plant. Figure B-2
- (b) Light oil refining plant. Figure B-3

14. Light Oil Recovery Plant

The benzolized wash oil draining into the base of the benzol washers is pumped to the light oil recovery system. It first enters a vapor-to-oil heat exchanger. The cold benzolized oil enters the bottom of the exchanger, flows up through tubes and is heated by the mixture of steam and light-oil vapors (coming from the stripping still) flowing downward in the space around the tubes. There is some condensation of steam and the lighter oil fractions in the heat exchanger. This condensate passes into a separator, the recovered oil being introduced into the feed line of the stripping stills, the water going to the intercepting sump.

The preheated benzolized oil enters a final heater where its temperature is further raised by indirect heat exchange with low-pressure

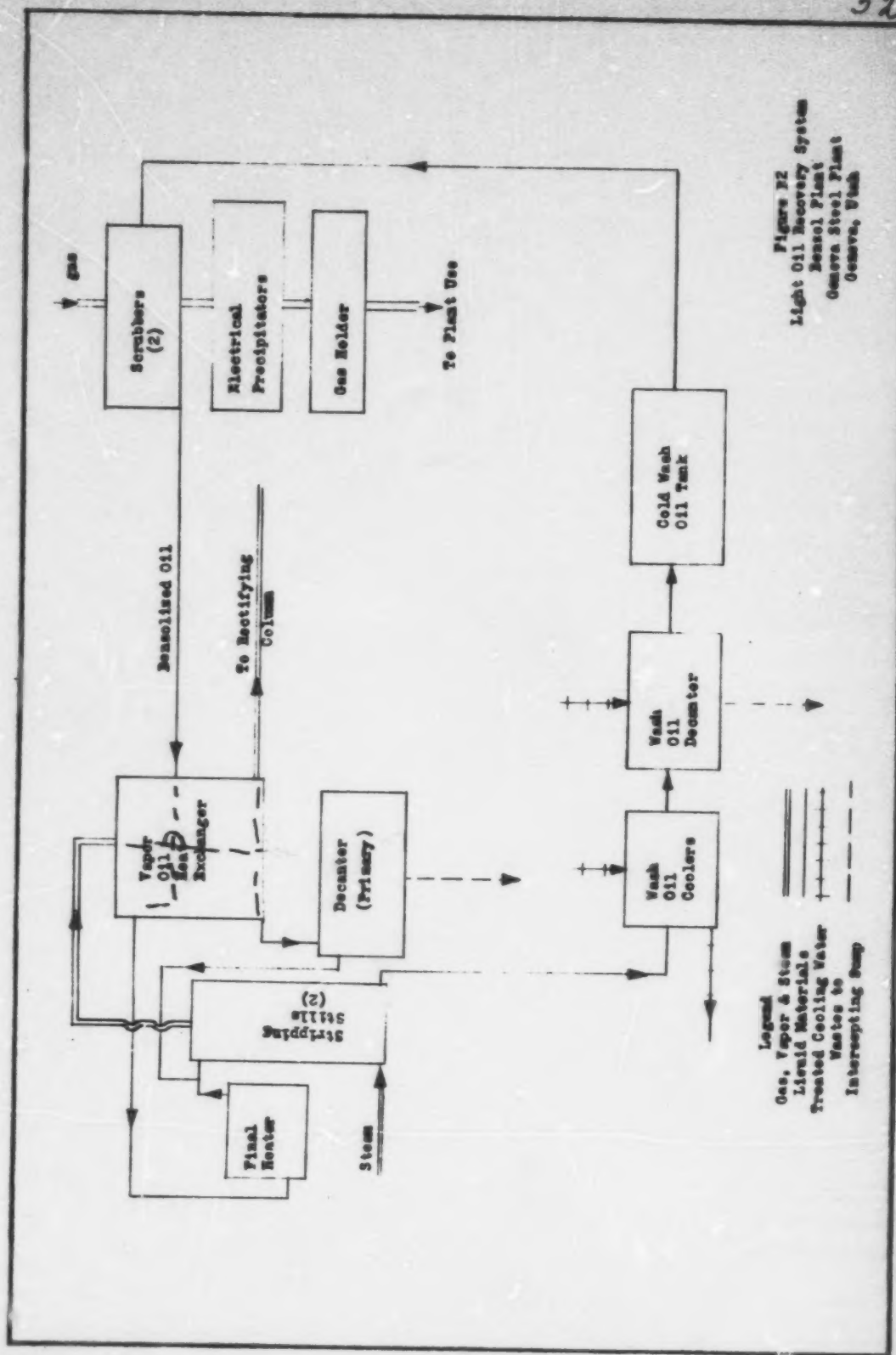


Figure #2
Light Oil Recovery System
Benzol Plant
Omnara Steel Plant
Omaha, Utah

Legend
 Gas, Vapor & Steam
 Liquid Materials
 Treated Cooling Water
 Wastes to Intercepting Pump

steam. The hot oil then enters the top of the stripping or wash oil still where it flows down over a series of bubble trays. Steam admitted at the bottom passes upward, distilling out the light-oil vapors. The debenzolized wash oil flows down to the base of the still, from where it is pumped to coolers.

Tubular type coolers cool the hot debenzolized wash oil from 244°F. (118°C.) to 93°F. (34°C.). The cooled oil then passes through a large wash oil decanter where it is washed with cold treated water at the rate of 60 gallons per minute. The decanted wash water flows to the intercepting sump, while the washed wash oil flows to a storage tank for recirculation to the gas scrubbers.

The steam and light-oil vapors leaving the top of the stripping mill enter the vapor-to-oil heat exchanger to raise the temperature of the incoming benzolized oil. On leaving the heat exchanger, the vapors enter the rectifying column of the light oil refining plant.

15. Light Oil Refining Plant

(1) Rectifying Column - The primary purpose of the rectifying column is to separate continuously the heavy fractions from the light fractions. The column consists of two sections, the top one being called the fractionating column and the bottom one being called the rectifying column.

The hot light oil and vapors from the stripping stills pass into the fractionating column where the lighter fractions are distilled off and pass out of the top of the column. These fractions are called

secondary light oil and are passed through a condenser and decanter (secondary decanter) in series. The secondary light oil then passes to storage prior to treatment in the CS_2 column, while the separated water runs to the intercepting sump. There is also a decanter on the side of the fractionating column which continually removes water from the light oil circulating through it.

The heavy fractions of the light oil flow to the bottom of the fractionating column and then through a decanter (intermediate). Separated water flows to the benzol plant intercepting sump, while the oil flows down through a rectifying column and is drawn off as crude or intermediate light oil.

(2) Forerunnings or CS_2 Column - The secondary light oil from the fractionating column of the rectifier passes through a continuous CS_2 or forerunnings column whose primary function is to reduce the sulfur content of the light oil. This unit consists of a steam-heated reboiler and a column containing trays. Forerunning vapors leave the top of the column and pass through a condenser and separator. Gases are vented off into the oven fuel gas line, while condensed oils are fed back into the top of the column for refluxing. The liquid bottoms are continuously drawn off to storage and pumped to the agitators for acid washing, as required. This oil is called crude BTX and consists essentially of benzene, toluene and xylene. Water from the separator or decanter is run to the benzol plant intercepting sump.

(3) Agitators - The crude BTX is pumped to agitators where it is washed with concentrated sulfuric acid to remove such undesirable compounds as unsaturated hydrocarbons. Four hundred gallons of 66° Be. sulfuric acid are added to 10,000 gallons of crude BTX in the cylindrical agitators (2) with conical bottoms and the contents agitated with mechanical stirrers. After several hours of settling, the acid and sludge are drawn off the bottom into sludge cars and hauled to a dump. One thousand gallons of wash water are then added and, after a period of mixing and settling, are drawn off into sludge cars for disposal on a dump. The acid-washed BTX is finally washed with 200 gallons of 50 per cent caustic solution and, after periods of mixing and quiescence, is dumped to the benzol plant intercepting sump. Sufficient spent caustic wash solution is periodically run from the agitators to the naphthalene decanting tanks in order to make a good naphthalene-water separation.

(4) Motor Fuel Column - Washed crude BTX is pumped to the motor fuel column for recovery of benzol. Benzol vapors leave the top of the column and pass through a condenser and separator in series. Enough benzol for proper refluxing is bled back into the top of the column, while the remainder flows into a storage tank. Water from the decanter or separator is run to the intercepting sump. By proper temperature control, 95 per cent of the benzol is removed from the crude BTX.

(5) Pure Still - The bottoms from the benzol still are processed in the pure still kettle and rectifying column. The remaining benzol is first removed and then the toluol and xylol in successive frac-

tionating steps by proper temperature and refluxing controls. The products are circulated through the condenser and separator before going to reflux and storage. Water from the separator is run to the intercepting sump.

(6) Crude Still - The crude or intermediate light oil fraction from the bottom of the light oil rectifier is similarly processed in the crude still kettle and rectifying column. This is a batch process, and solvent naphtha is first drawn off. The crude still kettle acts as a reboiler, and when all of the naphtha has been distilled off, the naphthalene is removed. This naphthalene flows to a large heated decanting tank where it is separated from the water and pumped to storage. Waste caustic solution from the agitators is added, which takes up the water and makes a solution with a density greater than that of the naphthalene. After a period of settling, the caustic solution is drawn off the bottom to the benzol plant intercepting sump.

Residue from the bottom of the crude still is burned in the open-hearth furnaces.

SURVEY PROCEDURES

16. Sample Collection

Samples were collected by plant personnel from the following points at the time of the survey:

- (1) Ammonia still influent
- (2) Ammonia still effluent
- (3) Dephenolizing unit influent
- (4) Dephenolizing unit effluent
- (5) Feed water to final coolers
- (6) Cooling water from final coolers
- (7) Primary decanter effluent
- (8) Secondary decanter effluent
- (9) Intermediate decanter effluent
- (10) Wash oil decanter effluent
- (11) Caustic from agitators
- (12) Caustic from naphthalene decanter
- (13) Benzol plant sewer
- (14) Benzol plant pond sewer line.

The samples were collected at hourly intervals for 24-hour periods from 5 AM to 5 AM and composited. Equal portions were taken at all stations except the benzol plant sewer and the benzol plant pond sewer where increments were taken according to flows. The only exceptions to this schedule were the caustic samples from the agitators

and the naphthalene decanter where samples were composited over 15-minute intervals using 200 ml. Erlenmeyer flasks. The agitators were dumped in about 15 minutes and the decanter was drained periodically for short time periods.

Separate samples were collected for the cyanide, phenol and sulfide determinations. The cyanide samples were preserved by adding pellets of sodium hydroxide to the sample bottles before sampling. The sulfide samples were preserved by adding approximately a gram of zinc acetate to each gallon bottle before sampling. The phenol samples were preserved by adding approximately 4 grams of copper sulfate to gallon bottles before sampling.

17. Flow Measurements

(1) Ammonia Still Influent - Daily records of the volume of liquor fed to the ammonia still were obtained from the company.

(2) Ammonia Still Effluent - There was some increase in volume of the ammonia liquor as it passed through the still, being caused by condensation of steam and water present in the line slurry added to the fixed leg of the still. The increase in volume was calculated from the plant steam flow charts and plant records of line slurry added. The average increase in volume amounted to 28 per cent. It was assumed that this increase in volume was uniformly distributed between the free and fixed legs of the still.

(3) The volumes of ammonia liquor to and from the dephenolizing unit were the same because steam heating was indirect. They were taken as 114 per cent of the flow to the ammonia still.

(4) Decanter Effluents - It was not practical to make flow measurements for the effluents from the primary, secondary or intermediate decanters. A water meter was placed in the wash oil decanter line ahead of the decanter.

(5) Agitators and Naphthalene Decanter - It was not practical to measure the volumes of caustic solution from these units.

(6) The influent to the final coolers was determined from rates of flow of fluorescein dye, and pipe sizes and lengths. It was assumed that the volumes of the effluent and the influent were the same. Actually the volume of the effluent was slightly more than that of the influent because of condensation from the gas in the final coolers. The difference, however, was probably not more than 2 or 3 per cent.

(7) Benzol Plant Sewer - A 90° V-notch weir was placed in a manhole, and readings were obtained from a float-level recorder.

(8) Benzol Plant Pond Sewer - A 9-inch Parshall flume was installed in the ditch, and water levels were recorded during the sampling periods.

15. Laboratory Procedures

The following determinations were made on the samples collected:

Solids, total and total volatile

Phenols

Cyanides

Ammonia nitrogen, free, fixed and total

Sulfides (total)

Alkalinity, methyl orange and phenolphthalein

pH

5-day B.O.D. at 20°C

Thiocyanates.

In general, the procedures followed were as given in "Standard Methods for the Examination of Water and Sewage," 9th Edition. (1) The methylene blue method for sulfides was used.

Special procedures for the phenols, cyanides, thiocyanates and fixed ammonia were used and will be found in the appendix at the end of this report.

19. Explanation of Laboratory Analyses

A brief explanation of the various laboratory determinations is given in the appendix at the end of this report, and is intended to serve as an aid in the interpretation of the analytical results reported.

DISCUSSION OF RESULTS

Daily analytical results and quantities of waste constituents will be found in Tables B-1 and B-2, in the appendix of this section of the report.

Coke plant operations were normal during the period of the survey. The ammonia still was shut down for a short period of time because of a shortage of sulfuric acid, and sampling of this unit was discontinued during this period.

The amounts of by-products and the characteristics of the wastes produced are affected by such factors as the quantity of coal carbonized, coking time in ovens and coking temperatures, with carbonization temperature being the most important.

20. Production Data

Coal, coke and by-product production data were obtained from plant records and are given in Table B-3 in the appendix at the end of this section of the report. The average daily figures for the period of the survey are as follows:

Total materials charged to ovens	4,940 tons
Coke produced	3,281 tons
Gas produced	56,876,000 cu. ft.
Ammonium sulfate	108,767 lbs.
Tar	52,719 gals.
Light oil	19,086 gals.
Sodium phenolate	274 gals.
Ammonia liquor (from still)	131,802 gals.

21. Ammonia Still Operation

Ammonia still operations include dephenolizing operations because the Koppers dephenolizing unit operates within the ammonia still cycle.

The analysis of samples and the quantities of waste constituents during the period of the survey are given in Tables B-1 and B-2 in the appendix at the end of this section of the report. The average concentrations of significant waste constituents entering and leaving the ammonia still are as follows:

	Cyanides (CN) ppm	Phenols ppm	Ammonia Nitrogen			Thiocyanates (NH ₄ SCN) ppm
			Free ppm	Fixed ppm	Total ppm	
Influent	19.5	1410	2350.	709.	2770	1200
Effluent	3.9	217	19.7	95.4	124	1030

The average daily quantities and removals of significant waste constituents in the ammonia liquor entering and leaving the ammonia still are as follows:

	Cyanides (CN) lbs./day	Phenols lbs./day	Ammonia Nitrogen			Thiocyanates (NH ₄ SCN) lbs/day
			Free lbs/day	Fixed lbs/day	Total lbs/day	
Influent	16.7	1210	*2030.	*629	*2380	1030
Effluent	4.22	238	* 21.9	*103	* 136	1120
Removed	12.48	972	2008.1	526	2244	- 90**
% Removal	74.7	80.3	98.8	83.6	94.3	- 8.8**

* Average results - (See Table B-2)

** Represents increase rather than decrease.

These reductions of cyanides, phenols and ammonia nitrogen from the ammonia liquor are accomplished in different sections of the ammonia still, and the average per cent removals, based upon over-all still operations, are as follows:

	<u>Free Leg</u>	<u>Dephenolizing Unit</u>	<u>Fixed Leg</u>
Cyanides (CN)	90.0	18.8	- 8.8*
Phenols	34.5	62.8	2.7
Ammonia Nitrogen:			
Free	21.2**	- 0.44*	78.5**
Fixed	31.9**	50.4**	17.7**
Total	14.2	11.3	74.5

* Indicates increase rather than decrease.

** These values are inconsistent with the theories of ammonia still operation. The samples for ammonia nitrogen analysis were not preserved and ammonia could be lost from the strongly alkaline solutions. It would have been impossible to make free ammonia nitrogen determinations on samples preserved with sulfuric acid.

22. Koppers Dephenolizing Unit

This vapor recirculating unit operates within the ammonia still cycle. Its chief purpose is to remove phenol from the ammonia liquor in the form of sodium phenolate which can be sold as a commercial product.

The analyses of samples and the quantities of waste constituents during the period of the survey are given in Tables B-1 and B-2. The average concentrations of significant waste constituents in the ammonia liquor entering and leaving the dephenolizing unit are as follows:

	Cyanides (CN)	Phenols	Ammonia Nitrogen			Thiocyanates (NH ₄ SCN)
	ppm	ppm	Free ppm	Fixed ppm	Total ppm	ppm
Influent	5.6	895	1660	462	2020	1050
Effluent	3.2	270	1670	201	1880	1050

The average daily quantities of significant waste constituents in the ammonia liquor entering and leaving the dephenolizing unit during the period of the survey are as follows:

	Cyanides (CN)	Phenols	Ammonia Nitrogen			Thiocyanates (NH ₄ SCN)
	lbs/day	lbs/day	Free lbs/day	Fixed lbs/day	Total lbs/day	lbs/day
Influent	5.47	875	1600	461	2060	1020
Effluent	3.13	254	1610	196	1810	1030
Removed	2.34	611	- 10	265	250	- 10
%	42.9	69.9	- .63		12.1	- .98

The daily per cent removals of phenols from the ammonia liquor in the Koppers dephenolizing unit are as follows:

June-	3-4	4-5	5-6	13-14	14-15	Average
	72.9	71.5	58.3	70.8	77.6	70.2

Nine hundred and seventy-two pounds of phenols were removed from the ammonia liquor by over-all still operations, but only 611 pounds were removed by the dephenolizing unit. It may be assumed that 361 pounds (972 - 611 equals 361) of phenols were returned to the gas stream.

23. Final cooling water

The analyses of samples and quantities of waste constituents during the period of the survey are given in Tables B-1 and B-2. The average daily concentrations and quantities of significant waste constituents removed from the gas are as follows:

	<u>Concentrations</u>		<u>Quantities</u>		
	<u>Influent</u> ppm	<u>Effluent</u> ppm	<u>Influent</u> lbs/day	<u>Effluent</u> lbs/day	<u>Removed from Gas</u> lbs/day
Cyanides (CN)	13.5	137	121	1,220	1099
Sulfides (S)	.57	15	5.1	134	128.9
Phenols	1030	1140	9,210	10,200	990
Thiocyanates (NH ₄ SCN)	188	174	1,680	1,560	- 120*
5 day B.C.D.	2680	2890	24,000	25,900	1900

* Indicates loss rather than increase.

24. Benzol Plant Decanters

(1) Light Oil Decanters - Samples were taken from the effluents from the primary, secondary and intermediate decanters, which may be identified in Figures B-1 and B-2. The primary decanter is in the line from the vapor-oil heat exchanger to the stripping stills, in the light oil recovery section. The secondary decanter is in the secondary light oil line after the rectifier, while the intermediate decanter is between the two columns of the rectifier.

The results of analyses of samples during the period of the survey are given in Table B-1.

It was impracticable to measure the flows from these decanters.

The average concentrations of waste constituents in these decanter effluents are as follows:

	Primary Decanter ppm	Secondary Decanter ppm	Intermediate Decanter ppm
Cyanides (CN)	4.5	235.	7.8
Phenols	418.	29.4	238.
Sulfides (S)	1.3	135.	5.
Thiocyanates (NH ₄ SCN)	31.	5.3	4.
5-day B.O.D.	1040.	357.	865.
Total Solids	62.	93.	259.
pH	6.9 - 7.3	6.5 - 6.6	7.7 - 7.9

(2) Wash Oil Decanter - This decanter may be identified in Figure B-2, and is mentioned in Item 14, page 54. The analyses of samples and quantities of waste constituents during the period of the survey are given in Tables B-1 and B-2. The average concentrations and daily quantities of significant waste constituents leaving the decanter and flowing into the benzol plant intercepting sump are as follows:

	Concentration ppm	Q u a n t i t i e s		
		Decanter Effluent lbs/day	In Treated Water lbs/day	Removed by Decanter lbs/day
Cyanides (CN)	1.4	0.95	0	0.96
Phenols	24.1	16.1	0	16.1
Sulfides (S)	.07	.045	0	.045
Thiocyanates (NH ₄ SCN)	2.5	1.72	0	1.72
5-day B.O.D.	109.	73.	7.2	65.8

25. Agitators and Naphthalene Decanter

These units may be identified in Figure B-2 and are discussed in Item 15, page 56. The analyses of samples are given in Table B-1. Approximately ²⁰⁰(400) gallons of waste caustic were discharged with each dump of the agitators but it was impossible to calculate daily waste quantities because agitator dumpings were intermittent. The naphthalene decanter was also operated on a periodic basis. The average concentrations of significant waste constituents are as follows:

	Agitator ppm	Naphthalene Decanter ppm
Total solids		
Total	366,000	63,800
Volatile	186,000	5,360
Alkalinity		
Methyl orange	234,000	60,000
Phenolphthalein	194,000	47,000
Cyanides (CN)	0.8	0
Phenols	181	345
Ammonia nitrogen (free)	50	
Thiocyanates (NH_4SCN)	0	0
Sulfides (S)	0	0
5-day B.O.D.	3,700	1,210
pH	11.7 - 11.8	12

26. Benzol Plant Sewer

All of the liquid wastes from the benzol plant flow through an intercepting sump where the floating oils are continuously drawn off at the top and the solids are retained in the bottom. The oils are floated continuously over a weir into a trough and pumped to the wash oil system. The solids are periodically removed when the sump is cleaned out. The water-carried wastes from this sump flow to the north quench station sump and were sampled through a manhole in the sewer line.

The analyses of samples and quantities of waste constituents during the period of the survey are given in Tables B-1 and B-2. The average concentrations and daily quantities of significant waste constituents flowing from the benzol plant are as follows:

	Concentration ppm	Quantities lbs/day
Cyanides (CN)	25.1	43.
Sulfides (S)	14.4	22.9
Phenols	175.	278.
Thiocyanates (NH_4SCN)	34.5	55.6
5-day B.O.D.	784.	1240.
Ammonia nitrogen (free)	10.5	58.8
Oil	157.	242.
pH	10.4 - 11.9	

27. Benzol Plant Pond Effluent

The effluent from the benzol plant intercepting sump and the overflow from the final cooler hot sump both flow to an intercepting sump from which quench water for the north station is pumped. When the supply exceeds the demand, the overflow runs by gravity to a pond where the oils are skimmed off and solids settle out. When the liquid level reaches a certain point, it flows out through a pipe, with a submerged inlet, to the coke plant drain.

The analyses of samples and daily quantities of waste constituents during the period of the survey are given in Tables B-1 and B-2. The average concentrations and average daily gross and net quantities of significant waste constituents flowing from the coke plant are as follows:

	Concen- trations ppm	Gross Quantities lbs./day	Net Quantities lbs./day
Cyanides (CN)	6.1	0.81	0.81
Sulfides (S)	.56	.28	.28
Phenols	315.	44.7	44.7
Thiocyanates (NH_4SCN)	132.	15.1	15.1
5-day B.O.D.	992.	136.	134.
Ammonia nitrogen (free)	24.8	3.6	3.6
Oil	67.3	12.9	12.9

SUMMARY

(1) Unit production figures for the coke plant are as follows:

	Average Daily Production - Yield per Ton Charge	
Total materials charged	4,940.	tons
Coke produced	0.6641	ton
Gas produced	11,513.	cu. ft.
Ammonium sulfate	26.06	lbs.
Tar	10.67	gals.
Light oil	3.86	gals.
Sodium phenolate	0.056	gals.

(2) Ammonia Liquor - The average daily production of ammonia liquor in the coke plant was 103,680 gallons. There was an average increase in volume of 28 per cent in the ammonia still, resulting in a final ammonia liquor volume of 132,710 gallons per day.

Ammonia still operation is summarized as follows:

	A m m o n i a		L i q u o r		Per Cent Reduction
	To Still		From	Still	
	Concen- tration ppm	Quan- tities* lbs./day	Concen- tration ppm	Quan- tities* lbs./day	
Cyanides (CN)	19.5	16.7	3.9	4.22	74.7
Phenols	1410.	1210.	217.	238.	80.3
Ammonia nitrogen					
Free	2350.	2030.	19.7	21.9	98.8
Fixed	709.	629.	95.4	103.	83.6
Total	2770.	2380.	124.	136.	94.3

* Average daily values.

The Koppers dephenolizing unit operates within the ammonia still cycle. Its main function is to remove phenols from the ammonia liquor. The average phenol reduction in this unit during the period of the survey was 70.2 per cent.

(3) Final Cooling System - The average daily quantities of significant waste constituents removed from the gas in the final coolers by the cooling water during the period of the survey are as follows:

Cyanides (CN)	1100 lbs./day
Sulfides (S)	129
Phenols	990
5-day B.O.D.	1900

(4) Benzol Plant Wastes -

(a) Light Oil Decanters

The ranges of concentrations of significant waste constituents from these units are as follows:

Cyanides (CN)	4.5 - 235. ppm
Phenols	29.4 - 418.
Sulfides (S)	1.3 - 135.
Thiocyanates (NH_4SCN)	4. - 31.
5-day B.O.D.	357. - 1040.

(b) Wash Oil Decanter

The average daily quantities of significant wastes from this unit are as follows:

Cyanides (CN)	0.96 lbs.
Phenols	16.1
Sulfides (S)	0.045
Thiocyanates (NH_4SCN)	1.72
5-day B.O.D.	65.8

(c) Benzol Plant Sewer

The wastes from this sewer represent all the wastes released from the benzol plant. The average daily quantities and unit quantities of significant wastes are as follows:

	Quantities lbs./day	Lbs./1000 gals. Light Oil
Cyanides (CN)	43.	2.25
Sulfides (S)	14.4	.75
Phenols	278.	14.6
Thiocyanates (NH_4SCN)	55.6	2.91
5-day B.O.D.	1240.	64.8
Ammonia nitrogen (free)	58.8	3.08
Oil	242.	12.7

(5) Waste Sources and Quantities - The sources and quantities of significant waste constituents discharged from operational units in the coke plant are as follows (these were the only constituents for which analyses were made on samples from all units):

	Phenols <u>lbs.</u>	Cyanides (CN) <u>lbs./day</u>	Thiocyanates (NH ₄ SCN) <u>lbs./day</u>	B.O.D. 5-day <u>lbs./day</u>
Ammonia liquor (from still)	238	4.22	1120.	1400
Water from final coolers	990	1100.		1900
Benzol plant sewer	<u>278</u>	<u>43.0</u>	<u>55.6</u>	<u>1240</u>
Total	1506	1147.22	1175.6	4540
Unit quantities per ton coal charged	0.305	0.232	0.238	0.919

(6) Coke Plant Effluent - All of the water-carried wastes from the coke plant are used for quenching with the exception of those from the benzol plant pond. Accordingly, the gross and net quantities of significant waste constituents in the pond effluent represent all the wastes from this plant. The average daily quantities are as follows:

	Gross <u>lbs./day</u>	Net <u>lbs./day</u>
Cyanides (CN)	0.81	0.81
Sulfides (S)	.28	.28
Phenols	44.7	44.7
Thiocyanates (NH ₄ SCN)	15.1	15.1
5-day B.O.D.	136.	134.
Ammonia nitrogen (free)	3.6	3.6
Oil	12.9	12.9

The unit net quantities of significant waste constituents discharged from the coke plant to the outfall sewer are as follows:

	<u>Pounds per Ton Charge</u>
Cyanides (CN)	0.00016
Sulfides (S)	0.000057
Phenols	0.009
Thiocyanates (NH_4SCN)	0.0031
5-day B.O.D.	0.027
Ammonia nitrogen (free)	0.00073
Oil	0.0026

Table B-1
(Results in parts per million)Coke Plant
Geneva Steel Plant
Geneva, Utah

Date 1951	Sam- ple No.	Alkalinity		pH	Cya- nide (CN)	Phenols		Ammonia Nitrogen		Thio- cyanates NH ₄ SCN	Chlo- ride	Total Solids		BOD 5- day	Sulfide (S)
		M.O.	Phenol- phtha'in			Free	Fixed	Free	Fixed			Total	Vola- tile		
June 3-4	C1	4,810	Ammonia	8.9	13.1	11	149	11	149	ent	3130				
4-5	C11	5,080	13.1	8.9	1338		2640		1370	1370	2410				
5-6	C21	2,920	15.9	9.0	1394		2740		1030	1030	2230				
13-14	C81	5,020	29.7	8.8	1463	1490	1250	168	1194	1194					
14-15	C91	5,100	19.8	8.8	1439	2775	70	2766	1198	1207	2590				
Average		4,586	16.8	8.8-9.0	1399	2793	70	2766	1198	1198	2590				
June 3-4	C2	1,882	Ammonia	11.4	2.1	11	149	11	149	ent	1980	9,606	3,730	1,058	
4-5	C12	2,040	2.1	10.4	2.7	189	86	178	989	989	1940	9,640	4,176	1,290	
5-6	C22	1,840	680	11.4	2.9	327	22.6	22.7	1045	1045	1830	1,756	352	1,595	
13-14	C82	2,614	804	10.8	5.5	239	16.8	168	1007	1007		10,054	3,736	1,360	
14-15	C92	2,516	1,660	11.5	6.2	181	19.7	95.4	1050	1050		10,494	3,290	1,080	
Average		2,173	1,048	10.4-11.5	3.9	217	19.7	95.4	1026	1026	1917	8,310	3,057	1,277	
June 3-4	C3	2,170	Phenols	8.8	5.1	745	Unit	Unit	Unit	Unit	Unit				
4-5	C13	2,490	5.1	8.8	5.0	858	1810	1097	1470	1470	1640				
5-6	C23	2,180	4.0	8.9	4.0	941	1900	1070	1880	1880					
13-14	C83	4,020	7.1	8.8	7.1	976	895	965	1018	1018					
14-15	C93	3,034	7.0	8.8	7.0	957	238	2293	993	993	1663				
Average		2,779	535	8.8-8.9	5.6	895	182	2293	1045	1045	1663				
June 3-4	C4	2,340	Phenols	8.8	1.8	202	Unit	Unit	Unit	Unit	Unit				
4-5	C14	2,580	1.8	8.8	3.3	258	1850	1082	1760	1760	2010				
5-6	C24	2,260	3.3	8.9	2.7	392	1940	1090	1980	1980					
13-14	C84	4,606	4.2	8.9	4.2	285	214	2225	1032	1032					
14-15	C94	4,006	920	8.9	3.8	219	2257	1000	1000	1000	1917				
Average		3,158	780	8.8-8.9	3.2	270	201	1882	1051	1051	1917				

Coke Plant
Geneva Steel Plant
Geneva, Utah

Table B-1, Continued - Summary of Laboratory Analyses
(Results in parts per million)

(Sheet 2 of 3)

Date 1951	Sam- ple No.	Alkalinity		pH	Cya- nide (CN)	Pho- nols	Ammonia Nitrogen		Thio- cyanates NH ₄ SCN	Chlo- ride	Total Solids		B.O.D. 5-day	Sul- fide (S)
		M.O.	Phenol- phtha'n				Free	Fixed			Total	Volu- tile		
June 7-8	C47	178,300	151,500	11.8	0.8	37.2	Agitation		0				2240	0
10-11	C57	353,400	290,500	11.8	0.8	246			0		339,800	166,740	3250	0
11-12	C67	170,000	140,600	11.7		260			0		391,600	204,420	5300	0
Average		233,900	194,230	11.7-11.8	0.8	181	Decanter		0		365,700	185,580	3697	0
June 10-11	C58	60,000	47,000	12.2	0	345	Decanter		0		63,760	5,360	1210	0
June 10-11	X1	170		7.3	4.3	339	Effluent		32.8		54	54	906	1.0
11-12	X11	164		7.1	4.8	444			28.5		24	24	990	1.5
12-13	X21	159		6.9	4.4	470			31.2		108	96	1210	1.5
Average		164		6.9-7.3	4.5	418	Effluent		30.8		62	57	1035	1.3
June 10-11	X2	690		6.5	221	28.4	Decanter		0		58	56	404	135
11-12	X12	594		6.5	236	33			11.4		138	62	188	165
12-13	X22	718		6.6	249	26.8			4.5		82	46	480	105
Average		667		6.5-6.6	235	29.4	Decanter		5.3		93	55	357	135
June 10-11	X3	440		7.7	7.9	230	Effluent		0		186	54	936	4.5
11-12	X13	489		7.9	7.5	259			6.8		408	118	728	5.3
12-13	X23	440		7.9	8.1	226			5.3		182	146	930	5.3
Average		456		7.7-7.9	7.8	238	Decanter		4.0		259	106	865	5.0
June 10-11	X4	147		7.6	0.1	21.1	Decanter		0		434	104	92	0
11-12	X14	140		8.0	1.4	22.7			7.6		430	160	124	0.1
12-13	X24	146		7.5	1.7	28.4			0		436	212	112	0.1
Average		144		7.5-8.0	1.4	24.1			2.5		433	159	109	0.07

Table B-1, Continued - Summary of Laboratory Analyses
(Results in parts per million)

Coke Plant
Geneva Steel Plant
Geneva, Utah

(Sheet 3 of 3)

Date 1951	Sam- ple No.	Alkalinity		pH	Cya- nide (CN)	Phe- nols	Ammonia Nitrogen		Thio- cyanates Total NH ₄ SCN	Chlo- rides	Total Solids		BOD 5- day	Sal- fide (S)	Oil
		M.O.	Phenol- phtha'n				Free	Fixed			Total	Vola- tile			
Water															
June 13-14	089	343		7.2	9.9	1110	Final		241		1,082	756	2740	0.75	
June 14-15	099	331		7.3	17.1	944			134		950	530	2610	.38	
Average		337		7.2-7.3	13.5	1027			188		1,016	643	2675	.57	
Water															
June 13-14	090	366		7.2	136	1175	Final		216		1,254	810	2960	15.	
June 14-15	0100	375		7.0	137	1095			132		908	508	2820	15.	
Average		381		7.0-7.2	137	1135			174		1,081	659	2890	15.	
Plant															
June 3-4	05	2,076		11.9	34.8	115	Plant	sewer	14.7	53.1	3,466	520	814	15.	
June 4-5	015	1,860		11.9	29.9	166			157.	39.	3,348	1,020	804	15.	
June 5-6	025	1,860	1,300	11.9	35.5	171			20.4	26.6	3,390	780	856	15.	
June 6-7	035	1,620	1,070	11.7	36.2	219			15.5	19.5	3,172	1,302	1015	15.	170
June 7-8	045	1,132	592	11.4	27.7	185			18.9		1,580	192	738	15.	239
Sewer															
June 10-11	055	626	230	10.4	17.5	213			17.	17.	834	258	1448	11.3	175
June 11-12	065	1,266	766	11.5	17.1	152			22.4		2,206	528	646	13.5	78
June 12-13	075	1,886	1,336	11.7	21.8	179			10.6		3,180	858	954	15.	122
Average		1,541	882	10.4-11.9	25.1	175			34.5	34.6	2,647	682	784	14.4	157
Pond															
June 3-4	06	530		9.5	6.9	286			174	105	1,186	334	1044	1.5	
June 4-5	016	640		9.5	6.9	317			27	106	1,914	322	932	0	
June 5-6	026	500	120	9.3	330	17.6			160	122	1,758	330	918	.75	
June 6-7	036	498	160	9.3	4.4	328			166	110	1,708	352	1075	0	67.3
Average		555	140	9.3-9.5	6.1	315			132	111	1,817	335	992	.56	67.3

Coke Plant
Geneva Steel Plant
Geneva, Utah

Table B-2 - Quantities of Waste Constituents
(Pounds per day)

(Sheet 1 of 3)

Date 1951	Sam- ple No.	Flow MGD	Total Solids		Alkalinity		Cya- nides (CN)	Phe- nols	Ammonia Nitrogen		Thiocy- anates NH ₄ SCN	Chlo- rides	BOD 5- day	Sul- fides (S)
			Total	Vola- tile	M.O.	Phenol- phtha'n.			Free	Fixed				
Ammonia Still Influent														
June 3-4	C1	0.101			4032		11.0	1122			1148	2624		
4-5	C11	.1095			4617		15.4	1267			936	2190		
5-6	C21	.1079			2615		26.6	1310		1119	1066	1997		
13-14	C81	.0995			4145	2086	16.4	1188	1334	139	986			
14-15	C91	.1005			4254	1889	14.0	1167	2291	2330	1007			
Average		.1037			3946	2020	15.7	1211	2025	629	1031	2229		
Ammonia Still Effluent														
June 3-4	C2	.1296	10333	4012	2024		2.26	160			1064	2130	1138	
4-5	C12	.1342	10737	4651	2272		3.01	210		191.	1158	2161	1437	
5-6	C22	.1375	2004	402	2100	776	3.31	373	25.8	25.9	1993	2088	1820	
13-14	C82	.1290	10768	4001	2800	861	5.89	256	18.0	180.	1078		1457	
14-15	C92	.1287	11210	3514	2688	1773	6.62	193			1121		1364	
Average		.1316	9091	3316	2383	1146	4.22	238	21.9	103.	1122	2097	1397	
Daphenolizing Unit Influent														
June 3-4	C3	.1153			2077		4.38	713			1732	1407		
4-5	C13	.1218			2518		5.06	858			1921	1659		
5-6	C23	.1227			2220		4.07	958	911	983	1090	1915		
13-14	C83	.1143			3812	288	6.73	926	1331	226	965			
14-15	C93	.1146			2886	729	6.66	910	2008	173	945			
Average		.1177			2716	523	5.47	875	1600	461	1021	1625		

Coke Plant
Geneva Steel Plant
Geneva, Utah

Table B-2, Continued - Quantities of Waste Constituents
(Pounds per day)

(Sheet 2 of 3)

Date 1951	Sam- ple No.	Flow MGD	Total Solids		Alkalinity		Cya- nides (CN)	Phe- nols	Ammonia Nitrogen		Thiocy- anates NH ₄ SCN	Chlo- rides	BOD 5- day	Sul- fides (S)	Oil
			Total	Volat- ile	M.O. phtha- lic	Phenol- ic			Free	Fixed					
Dephenolizing Unit Effluent															
June 3-4	C3	0.1153			2239		1.72	193			1770	1035	1684		
4-5	C13	.121344			2469		3.16	247			1857	1924	1924		
5-6	C23	.122695			2302		2.75	399	912	213	1130	1110	2016		
13-14	C83	.114258			4368	607	3.93	270	1900	210	2110	979			
14-15	C93	.1146			3810	875	3.61	204	2016	160	2175	951			
Average		.117739			3086	762	3.13	264	1609	196	1808	1027	1873		
Water to Final Cooler															
June 13-14	C89	1.08	9699	6777	3075		88.7	9950			2160		24561	6.72	
14-15	C99	1.08	8516	4751	2967		153.	8462			1201		23396	3.41	
Average		1.08	9108	5764	3021		121.	9206			1681		23979	5.07	
Water from Final Cooler															
June 13-14	C90	1.08	11240	7260	3460		1219	10532			1936		26533	134	
14-15	C100	1.03	8139	4554	3362		1228	9816			1133		25278	134	
Average		1.03	9690	5907	3411		1224	10174			1560		25906	134	
Wash Oil Decanter															
June 10-11	X4	0.0791	285	68	96		0.79	13.8			0		60	0	
11-12	X14	.0316	291	108	95		.95	15.4			5.15		84	.068	
12-13	X24	.0315	295	143	99		1.15	19.2			0		76	.068	
Average		.0803	290	106	96		.96	16.1			1.72		73	.045	

Coke Plant
Geneva Steel Plant
Geneva, Utah

Table B-2. Continued - Quantities of Waste Constituents
(Pounds per day)

(Sheet 3 of 3)

Date 1951	Sam- ple No.	Flow MGD	Total Solids		Alkalinity		Cya- nides (CN)	Phe- nols	Ammonia Nitrogen		Thiocy- anates NH ₄ SON	Chlor- rides	BOD 5- day	Sul- fides (S)	Oil
			Total	Vola- tile	N.O.	Phenol- phtha'n			Free	Fixed					
Benzol Plant Sewer															
June 3-4	C5	0.2009	5779	567	3461		58.0	192	5.31		24.5	88.0	1357	25.0	
4-5	C15	.1944	5402	1646	3001		48.2	263	9.04		253.	62.9	1297	24.2	
5-6	C25	.1944	5470	1259	3001	2098	57.3	276	8.39		32.9	42.9	1381	24.2	
6-7	C35	.1296	3412	1401	1743	1151	38.9	236	30.1		16.7	21.0	1092	16.1	183
7-8	C45	.1750	2294	279	1644	860	40.2	269	36.6		27.4		1072	21.8	347
10-11	C55	.2203	1525	472	1145	421	32.0	390			31.0		819	20.7	320
11-12	C65	.2203	4034	966	2315	1400	31.3	278			41.0		1181	24.7	142
12-13	C75	.2138	5644	1523	3347	2371	38.7	318			18.8		1693	26.6	216
Average		.1936	4195	1051	2457	1383	43.0	278	58.8		55.6	53.7	1236	22.9	242
Benzol Plant Pond Effluent															
June 3-4	C6	.0109	170	30.2	52.4		0.62	25.8	2.1		15.7	9.49	94	0.136	
4-5	C16	.0266	422	71.	141.		1.52	69.9	5.29		5.95	23.4	206	0	
5-6	C26	.0159	232	43.5	65.9	15.8		43.5	2.32		21.1	16.1	121	0.99	
6-7	C36	.0231	213	67.6	95.6	30.7	.84	53.0	6.64		31.9	21.1	206	0	12.9
Average		.0121	221	46.3	76.2	23.2	.81	44.7	3.61		15.1	15.4	157	0.282	12.9

Coke Plant
Geneva Steel Plant
Geneva, Utah

Table E-3 --
Daily Production Figures (a)

Date 1951	Total Material Charged tons (b)	Coke Pro- duced tons	Gas(c) Pro- duced 1000 cu.ft.	Ammo- nium Sulfate lbs.	Tar gals.	Light Oil gals.	Sodium Phe- nolate gals.	Ammonia Liquor (from still) gals.
June 3-4	4,932	3,363	56,762	130,702	52,280	19,296	38	129,600
4-5	4,942	3,351	57,338	136,394	61,350	19,332	185	134,187
5-6	4,942	3,438	57,016	131,833	58,000	19,397	289	137,490
13-14	4,942	3,099	56,658	119,210	50,516	18,921	376	129,035
14-15	4,942	3,152	56,604	125,694	41,451	18,485	484	128,700
Average	4,940	3,281	56,876	108,767	52,719	19,036	274	131,802

(a) Average coking time 17 hours. Average number ovens charged 348.
Average charge per oven 14.2 tons. Average oven temperature 2250°F.

(b) 82% high volatile coal, 14% low volatile coal, 4% pitch.

(c) Average heating value of 563 BTU.

Daily Production Figures - Yield per Ton Charge

June 3-4		0.6819	11.509	26.49	10.60	3.92	0.008	26.28
4-5		.6781	11.601	27.60	12.41	3.91	.037	27.15
5-6		.6957	11.537	26.67	11.74	3.93	.058	27.82
13-14		.6271	11.464	24.13	10.22	3.81	.076	26.11
14-15		.6378	11.453	25.42	8.39	3.74	.098	26.05
Average		0.6641	11.513	26.06	10.67	3.86	0.056	26.68

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SECTION C - ROLLING MILL OPERATIONS

DESCRIPTION OF PROCESS

Rolling mill operations consist of transforming steel in its bulk form as delivered from the open-hearth furnaces to the desired dimensions of sheets, plates and structural shapes. This changing of shape of the steel is accomplished by means of passing the heated rudimentary shapes between numerous massive polished steel rolls. Rolling operations are performed in three major departments at this plant, namely: (1) slab and bloom mill, (2) plate and hot strip mill, and (3) structural mill.

1. Slab-Bloom Mill

Steel is delivered from the open-hearth furnaces in the form of ingots. Ingots are rectangular block-like shapes weighing 5-1/2 to 22 tons. The ingots are heated to about 2250°F. in brick-lined, gas-fired furnaces referred to as soaking pits. From the soaking pits they are placed on roller tables which convey them to the 45" x 115" reversing two-high slab mill. The ingot is passed several times back and forth through this mill, being reduced in thickness and correspondingly lengthened each pass. Following the mill is a set of vertical edger rolls which control the width and square the edges of the flattened and elongated ingot. The mill and subsequent equipment is used to form both slabs and blooms. A slab from this mill has a cross section of 24" to 60" in width by 4" to 9" in thickness, whereas blooms range from 5 x 7" to 14 x 14". The slabs and blooms are cut to the

desired length of about 7 to 18 feet respectively by means of a shearing machine. Rough ends of the piece delivered from the mill are also sheared off by this machine. These ends, called "crops," are conveyed to a large tank of water called the crop pit in which they are cooled so that they may be returned to the open hearth for charging. The blooms are sent to the structural mill and the slabs are run either directly to the plate mill or to storage.

The rolls and bearings of the mills are cooled and cleaned by sprays of water. Water is also sprayed on the ingot to flush off scale.

2. Plate and Hot Strip Mill

Slabs, either as produced or from storage, are rolled to plates or thin sheet form in this mill. Slabs from storage are passed through a scarfing yard in which oxyacetylene torches are used to remove surface imperfections. The slabs are then reheated to about 2250°F. in gas-fired reheat furnaces. The first operation of the plate and strip mill is the removal of scale from the slabs by means of rolls and high-pressure (1400 psi) water sprays. Following the scale-breaker and descaling sprays, the metal shape is gradually thinned, elongated, and its edges kept trim by passing it in turn through the rolls of a spreading stand, a slab squeezer, a vertical edger, a reversing rougher, a second scale-breaker and descaling spray, and finally six continuous finishing stands. The slab is thus converted to a plate or sheet of thin steel. The metal passes from the finishing stands out over a runout table on which it is cooled by water sprays. For producing

plate, the steel is leveled, trimmed, and cut into ordered lengths. When strip is run, it is coiled in either of two downcoilers and then transferred by conveyor to coil shipping. The coils, weighing 4 to 10 tons each, are shipped to West Coast mills for further processing.

The rolls of the mills are cooled and cleaned by sprays of water. Water under extreme pressure (1400 psi) is directed on the slab in the descaling sprays for the purpose of removing scale.

3. Structural Mill

Blooms are transformed to various structural shapes in the structural mill. This mill is equipped to make eight different shapes, namely: equal angles, unequal angles, channels, I beams, Z beams, bulb angles, billets, and standard beams. It is equipped with one 32-inch (2 high) reversing mill and one 3-stand 26-inch structural mill.

Blooms are heated in a gas-fired reheat furnace and then passed through a reversing roughing mill. Having been reduced to the required size, the bars are then run through the stands of the roughing structural mill. The roughly formed shapes are then passed through finishing rolls, are cut into lengths with saws, cooled, and finally straightened and marketed.

The rolls of the mills are cooled and cleaned by sprays of water. Water under high pressure is used to remove scale from the shape being rolled.

OPERATING SCHEDULE AND PRODUCTION DATA

The operating schedule of the three rolling mill units during the survey was as follows:

Slab and bloom mill:

Seven days per week, two shifts -

8 A.M. to 4 P.M., and

8 P.M. to 5 A.M.

Plate Mill:

Monday through Friday, continuous operation

Structural Mill:

Monday through Friday, one shift -

8 A.M. to 4 P.M.

Production data for the first five months of 1951, for each of the mill divisions, are as follows:

Month 1951	Slab-Bloom Mill		Plate Mill		Structural Mill	
	Total Ingots Rolled in Month Tons	Number of 8-hour Turns Worked	Slabs Rolled in Month Tons	Number of 8-hour Turns Worked	Tons of Blooms and Billets Rolled in Month	Number of 8-hour Turns Worked
Jan	141,918	79.	120,168	73	10,538	27.5
Feb	118,713	60.4	98,611	60	10,829	24
March	148,133	75.7	111,685	69	9,743	25
April	133,546	72.9	102,336	63	9,363	19
May	131,924	69.8	109,761	70	11,573	27

Average daily production figures corresponding to these data and figuring seven-day-per-week operation of the slab mill and five-day-per-week operation of the other two mills, are as follows:

<u>Mill</u>	<u>Tons Rolled per Day</u>
Slab-Bloom	4,460
Plate	5,090
Structural	493

On a yearly basis, extrapolating the 5-month figures for 1951 to a year, quantities of steel rolled in the slab-bloom mill were as follows:

<u>Year</u>	<u>Slabs tons/year</u>	<u>Blooms tons/year</u>
1949	777,494	102,879
1950	1,159,058	104,512
1951	1,300,000	125,000

WASTE SOURCES

The main uses of water in rolling mill operations contributory to the wastes are for cooling; rolls and finished steel and for removing and transporting scale. The remaining use contributory to the wastes is for lubrication of phenolic-type bearings.

This water, on reaching the sewers, contains two principal objectionable constituents, namely: mill scale, which is particles of iron oxide and iron; and oil, which comes from losses in the lubrication system of the rolling mill.

4. Cooling and Descaling Wastes

Water sprayed on the rolls and on the product being rolled, drops to a steeply pitched concrete trough which is located below and parallel with the line of roller tables and machinery. This trough carries the waters to a large deep basin referred to as the scale pit. The scale pit provides a settling chamber in which scale contained in the waters may settle out. Scale is dredged from the pit once weekly. In order to sluice to the pit heavy pieces of scale which may enter the trough, a large flow of water is pumped from the

pit and introduced to the far end of the trough. This water returns through the trough to the pit, providing a rushing torrent which transports the largest pieces of scale.

Each of the three divisions of the rolling mill has a scale pit. The troughs and scale pits receive, besides the cooling and descaling water, water used to lubricate phenolic bearings. Water is pumped from the scale pits of the slab and plate mills to waste drains and to the untreated water supply collection chamber. Water from the structural mill is pumped to waste. The design of the scale pits is such that optimum conditions for sedimentation do not exist. Excessive turbulence produced by outlet and inlet conditions and the large volumes of water recirculated are factors limiting settling.

In addition to the above-mentioned uses of water, there is additional use of water for cooling motor bearings, air-to-water heat exchangers, and for cooling the skid pipes of the reheating furnace. This water is part of the closed cooling water system of this plant known as the treated water system and does not, with certain exceptions, enter the sewers. The treated water system is described in Section D of the report. The sewer returning cooling water from the plate mill reheating furnace to the treated water system is insufficient in capacity. The excess treated water, estimated at 400 gpm, overflows to the plate mill scale pit. Considerable "treated" water is used for roll cooling and for phenolic bearing lubrication. This water flows to the scale pits. Phenolic bearings are used on the journals of the drive shaft extending from

the motor room to the slab mill. They are also employed on the rolls of the descaling units of the plate mill.

Untreated water for cooling is passed through strainers before use, and that portion which is forced through the sprays of the descalers is passed through rapid sand filters before use.

Untreated water used in the slab mill is passed through a Brassert strainer. A continuous backwash of this filter, estimated at over 400 gpm, flows to the crop pit. From the crop pit, this water is pumped to the untreated water supply collection chamber. The excess water is needed in the crop pit in order to keep down the temperature of this water. A minor amount of cooling water from the edger in the slab mill also enters the crop pit.

5. Lubricating System

Various units of the mills are lubricated by means of oil under pressure. Oil is pumped to particular equipment and is then returned to the system's supply tank and recirculated. Filters are placed in the oil feed lines for removing scale, sludge, and other foreign material. These filters are cleaned weekly, the fouling material being caught in barrels and disposed of separately from water-borne wastes. In addition, at intervals of about one month, oil is drawn from the bottom of the oil supply tank and passed through centrifuges for the purpose of separating water and foreign material. The centrifuged oil is returned to the supply tank; the water and other matter is sewered. The tanks of the major oil circulating systems have capacities up to 24,000 gallons.

Certain units are lubricated by means of grease which is distributed through a system of pressure lines. Pumps, automatically actuated at intervals of as often as three minutes, force the grease required to the points of application.

Some heavy equipment is of the hydraulic type, in which the energy is transferred via oil. Pressures up to 4000 pounds per square inch are employed. These units are closed systems providing return and re-use of the oil.

Oil and grease enter the water-borne wastes through leaks from bearings and other points into the cooling and wash waters. Other oil in the wastes comes from leaks and spills from oil-handling equipment and from material separated by the centrifuges. An additional loss considered important at this mill is from breaks in pressure lines, particularly those in the hydraulic systems.

6. Machine Shop Wastes

In the machine shops of the structural mill where the rolls are cut and resurfaced, considerable soluble cutting oil, lubricating oil and solvents are used. These wastes are collected in a sump and disposed of on dumps.

SURVEY PROCEDURES

7. Sampling Points

Samples were collected by plant personnel from the following points:

- (1) Slab mill sewer
- (2) Plate mill sewer
- (3) Structural mill sewer
- (4) Combined slab and plate mill sewer
- (5) Rolling mill drain ditch.

Samples were collected at hourly intervals for 24-hour periods from 8:00 A.M. to 8:00 A.M. and composited, except for the structural mill sewer. Samples were collected from the structural mill sewer at hourly intervals during operation, 8:00 A.M. to 4:00 P.M., and composited. Plant operations and flows were fairly constant; accordingly all composites were made up of equal portions.

8. Laboratory Procedures

The following determinations were made on each sample:

Total solids, total and volatile
Suspended solids, total and volatile
Total iron
Oil
Chlorides.

In general, the procedures followed were as given in "Standard Methods for the Examination of Water and Sewage," 9th Edition.

Special procedures used for oils and iron are included in the appendix at the end of the report.

Chlorides and phosphates were determined for the purpose of making computations on the volume of treated water being wasted. The significance of other determinations is discussed in the appendix at the end of the report.

9. Flow Measurements

Water used in the rolling mills from the untreated water system is measured by an orifice meter. These records were used for waste flow data. Treated water used in the rolling mill is not metered. In order to obtain an estimate of treated water used, advantage was taken of a two-hour period on Saturday morning when all rolling mill operations are normally suspended. During this period, untreated water uses were closed and all treated water uses were turned on. Thus only treated water entered the mill sewers. The waste flow during this period was passed through a Parshall flume and a measurement obtained. This figure added to the meter records of untreated flow equals total rolling mill usage and was the figure used for waste flow.

An estimate of the amounts of treated water used in each of the mill divisions was made from determinations of the concentrations of chlorides in the two water supplies and in the wastes.

A portion of slab and plate mill wastes is returned to the untreated water supply collection chamber. Reference is made to Figure E-1 for a schematic representation of this system. The quantity of the wastes entering the rolling mill drain was measured by means of a Parshall flume equipped with a water-stage recorder. Total water use figures, less the flow in the rolling mill drain, gave an estimate of the amount of rolling mill wastes returned to the untreated water supply.

RESULTS

10. Volume and Characteristics of Wastes

Daily analytical results showing net concentration of solids, oil and iron in the wastes are listed on Table C-1. The values are net quantities, deductions for the concentrations existing in the water supply having been made. These values are for the wastes as produced, that is effluents from the scale pits, and do not reflect the reductions accomplished in the settling and oil skimming treatment which the combined wastes receive. The table lists production figures for correlation with the analytical results.

The data listed for total rolling mill wastes are the sum of data for the three mills. Also tabulated are data obtained from samples of the combined wastes in the rolling mill drain. As previously explained, part of these wastes are returned to the untreated water supply collection chamber and do not enter the rolling

mill drain. The data tabulated for "combined rolling mill wastes" are on a basis as if the total flow did go to the drain. These should be close estimates of rolling mill waste quantities of oil and solids reaching the outfall sewer, because much of the material returned with rolling mill wastes to the water supply collection chamber enters the plant drains via the collection chamber overflow and the sludge return.

The data for combined slab and plate mill wastes serve as a check on the data for these separate wastes.

One particular outstanding discrepancy is that of the results showing greater concentrations and quantities of iron than suspended solids. This is true in 12 of 17 results. For suspended solids results even to equal the iron results, the iron would have to be entirely unoxidized, which undoubtedly is not true. The most logical explanation is that the iron results are high. Suspended solids results are less subject to error, as the determination is much less complicated.

The totals of the quantities of solids, oil and iron in the three mill wastes agree fairly well with the data listed for combined rolling mill wastes. The combined waste quantities of solids, oil and iron are from 6 to 14 per cent greater than the sum of individual mill quantities.

The combined slab and plate mill wastes check closely the sum of quantities in the individual wastes. The average data for oil and iron check within one per cent, but suspended solids data differ by 20 per cent.

The various departments constitute the following proportion of rolling mill waste loads:

<u>Mill</u>	<u>Per Cent of Total</u>		
	<u>Suspended Solids</u>	<u>Oil</u>	<u>Iron</u>
Slab-Bloom	16	33	13
Plate-Strip	82	65	83
Structural	2	2	4

Tables containing daily analytical results will be found at the end of this section of the report.

11. Oil Losses

Two methods are available for estimating oils contained in the waste. One involves sampling and analysis of the waste for oil, and the second makes use of records of oil consumption in the units from which oil losses are likely to enter the sewers. Consideration of the nonuniformity with which oil may be distributed in the waters sampled limits the confidence that can be placed in data for oil losses obtained from sampling the wastes, much of the oil being insoluble and having a tendency to float on the surface. Data obtained by both methods at the Geneva mill are presented in the table titled "Oil Losses," which appears on page 99. Results are reported in part as pounds of oil, for the following reasons: (1) the determination is made on weight basis, (2) conversion of weights to volumes is difficult because the specific gravity of the various oils and greases differ, and (3) oil in large quantities is purchased on weight

basis. In the consumption record, oil and grease are listed by type of lubricant as designated at Geneva. This information, together with knowledge of which units utilize the various oil types, enables further tracing of oil losses. Limited information on the use of the lubricant types follows:

<u>Mill</u>	<u>Oil Type</u>	<u>Use</u>
Slab-Bloom Mill	EPT 130	Bloom and vertical edger drive. Table roll gear oil vats and drive-side bearings
	M 75	Roll balance hydraulic system of reversing mill. Hydraulic system of shear.
	M 1825	Vertical edger
	S 600	Turn-around-and-squeezer hydraulic system (water-soluble oil)
	Grease	One side of table rolls and some points on mill
Plate Mill	EPT 130	Pinions, drive and screwdowns on finishing and spreading stands and reversing mill
	M 75	Rollback tables for roll changing
	M 1825	Vertical edger
	Dectol X	Backup rolls on mill
Structural Mill	EPT 130	Bearings, pinions, etc., of various mills.

The nature of the operations and product is such that lubrication of the material being rolled is unnecessary.

The total figure from oil consumption records is 25 per cent less than losses figured from analysis of the wastes. The oil determination procedures used in this survey actually measure material

in the sample which is dissolved by a mixture of ether and carbon tetrachloride. Although it is doubtful if, besides oil and grease, much material soluble in these liquids was present in the wastes, any such material would lead to high oil results.

Oil Consumption Records

Mill	Oil Consumption Records						Oil in Wastes
	Oil and Grease Use by Year by Type, 450-lb. Drums						Oil and Grease, pounds per day
	EPF 130	M 75	M 1825	Dectol X	S 600	Grease	
Slab-Bloom	1070	197	29		48	646	2460
Plate	702	631	230	534			3630
Structural	24						41
Total rolling mill							6131
Total plant wastes**							8184

* Week days.

** Total plant wastes entering skimming pond on week days during rolling mill survey.

Slab-bloom mill	2.330	4.200	5.750
Plate mill	11.5	10.200	12.250
Structural mill	1.0	1.0	1.0
Total rolling mill wastes	14.8	15.400	17.000

SUMMARY

Based on analytical data obtained during this survey, net average concentrations of suspended solids, iron and oil, in the rolling mill wastes, are as follows:

Waste	Concentrations		
	Suspended Solids, p.p.m.	Iron, Total Fe, p.p.m.	Oil, p.p.m.
Slab-bloom mill	78	77	86
Plate mill	135	174	58
Structural mill	40	88	19
Total rolling mill wastes	116	146	63

The volume and net quantities of suspended solids, iron and oil, produced at this mill, were as follows:

Waste	Volume and		Quantity	
	Volume, million gallons /day	Suspended Solids, pounds/day	Iron, Total Fe, pounds/day	Oil, pounds/day
Slab-bloom mill	3.9	2,530	2,500	2,790
Plate mill	11.5	12,900	16,600	5,590
Structural mill	1.0	323	710	153
Total rolling mill wastes	16.4	15,800	19,900	8,540

These data give the following unit values of the net quantity of suspended solids, iron and oil contained in the wastes per ton of product. Summing appropriate values yields unit quantities per ton of plate or strip produced and per ton of structural shapes.

Line	Mill Waste	Unit Volumes and Quantities			
		Volume per Ton of Product gallons	Suspended Solids per Ton of Product pounds	Iron per Ton of Product pounds	Oil per Ton of Product pounds
1	Slab-bloom	1030	0.67	0.66	0.74
2	Plate	2260	2.54	3.27	1.10
3	Structural	1970	0.66	1.44	0.31
Total wastes for plate and strip (Lines 1 + 2)		3290	3.21	3.93	1.84
Total wastes for structural shapes (Lines 1 + 3)		3000	1.33	2.10	1.05

Rolling Mill
Geneva Steel Plant

Table C-1 - Net Concentrations and Quantities of Solids, Oil and Iron

Waste and Date	Flow mgd	Susp. Solids		Iron as Fe		Oil		Slabs tons	Blooms tons	Total tons
		ppm	pounds	ppm	pounds	ppm	pounds			
Slab-Bloom Mill										
June 17-18 8AM-3AM	4.0	113	3,760	116	3,860	98.6	3,280	2,874	585	3,459
18-19 8AM-3AM	3.9	66	2,150	55	1,790	63.7	2,070	3,126	611	3,737
19-20 8AM-3AM	3.9	67	2,180	78	2,540	110	3,580	3,082	625	3,707
20-21 8AM-3AM	3.9	66	2,150	58	1,880	70.8	2,300	3,810	415	4,225
Average	3.9	78	2,530 ^b	77	2,500 ^b	85.8	2,790 ^b			3,782
Plate-Strip Mill										
June 17-18 8AM-3AM	4.5 ^a	174 ^a	6,510 ^a	222 ^a	8,320 ^a	80.0 ^a	3,000 ^a	Plates 400 ^a	Coils 1,784 ^a	Total 2,184 ^a
18-19 8AM-3AM	11.4	124	11,800	182	17,300	54.5	5,180	1,197	4,730	5,927
19-20 8AM-3AM	11.3	142	13,400	170	16,000	63.7	6,000	2,399	2,325	4,724
20-21 8AM-3AM	11.9	102	10,100	170	16,900	56.9	5,640	4,617	0	4,617
Average	11.5	135	12,900 ^b	174	16,600 ^b	58.4	5,590 ^b			5,089
Structural Mill										
June 19-20 8AM-4PM	0.97	52	420	83	670	24.0	194			463
20-21 8AM-4PM	0.96	29	232	92	735	13.9	111			523
Average	0.965	40	323 ^b	88	710 ^b	13.9	153 ^b			493
Total Rolling Mill (Sum of above averages)										
	16.4	116	15,800 ^b	146	19,900 ^b	62.5	8,540 ^b			Structural Shapes 463
Combined Rolling Mill Wastes										
June 17-18 8AM-3AM	8.5	122 ^a	8,640 ^a	84 ^a	5,940 ^a	89.9 ^a	6,360 ^a			
18-19 8AM-3AM	16.3	133	13,100	164	22,300	78.7	10,700			
19-20	16.2	118	15,900	160	21,600	72.2	9,750			
20-21	16.7	115	16,000	140	19,500	68.6	9,550			
Average	16.4	122	16,700 ^b	155	21,200 ^b	73.2	10,000 ^b			
Combined Slab-Bloom and Plate-Strip Mill										
June 17-18 8AM-3AM	8.5 ^a	159 ^a	11,970 ^a	108 ^a	7,650 ^a	137	9,700 ^a			
18-19 8AM-3AM	15.3	143	13,200	159	20,200	55.3	8,380			
19-20 8AM-3AM	15.2	160	20,200			83.8	10,600			
20-21 8AM-3AM	15.3	142	18,700	141	13,600	67.5	8,890			
Average	15.4	153	19,600 ^b	150	19,200 ^b	72.4	9,280 ^b			

(a) Not included in average as plate-strip mill operated only 1/3 of day.

(b) Computed from average flow and concentration.

Rolling Mill
Geneva Steel Plant
Geneva, Utah

Table C-2 - Gross Concentration of Solids,
Iron and Oil in Rolling Mill Wastes

Date, 1951 8 AM - 8 AM	Total Solids		Suspended Solids		Iron as Fe ppm	Oil ppm
	Total ppm	Volatile ppm	Total ppm	Volatile ppm		
Slab-Bloom Mill Wastes						
June 17-18	508	162	138	75	128.	98.6
18-19	514	144	113	60	68.8	63.7
19-20	500	122	110	63	91.6	110.
20-21	568	204	127	78	72.	70.8
Average	523	158	122	69	90.1	85.8
Plate-Strip Mill Wastes						
June 17-18	546*	164*	202*	64*	236*	80 *
18-19	540	120	174	51	198	54.5
19-20	584	108	168	56	186	63.7
20-21	578	112	168	47	186	56.9
Average	567	113	176	51	190	58.3
Structural Mill Wastes						
June 19-20	496	72	108	17	104	24
20-21 (8AM-1PM)			109	22	113	13.9
Average	496	72	108	19.5	108	18.9
Combination Slab-Bloom and Plate-Strip Wastes						
June 17-18	620*	190*	196*	99*	121*	137. *
18-19	564	140	192	61	174	65.8
19-20	574	114	205	68	297	83.8
20-21	628	136	206	86	156	67.5
Average	583	146	201	71	209	72.3
Rolling Mill Drain						
June 17-18	572*	206*	149*	75*	97	89.9
18-19	554	93	183	53	180	78.7
19-20	570	132	163	62	176	72.2
20-21	628	136	181	72	156	63.6
Average	584	155	175	64	170	73.1

* Not included in average as plate-strip mill operated only 1/3 of day.

Rolling Mills
Geneva Steel Plant
Geneva, Utah

Table C-3 - Gross Quantities of Solids, Iron
and Oil in Rolling Mill Wastes

Date, 1951 8 AM- 5 AM	Flow mgd	Total Solids		Suspended Solids		Iron as Fe lbs.	Oil lbs.
		Total lbs.	Volatile lbs.	Total lbs.	Volatile lbs.		
Slab-Bloom Mill Wastes							
June 17-18	4.0	16,900	5,400	4,600	2,500	4,260	3,290
18-19	3.9	16,700	4,670	3,670	1,950	2,240	2,070
19-20	3.9	16,200	3,960	3,570	2,040	2,980	3,570
20-21	3.9	18,400	6,620	4,120	2,530	2,340	2,300
Average	3.9	17,100	5,160	3,990	2,260	2,960	2,810
Plate-Strip Mill Wastes							
June 17-18	4.5*	20,400	6,150	7,570	2,400	8,850	3,000
18-19	11.4	51,200	11,400	16,500	4,850	18,800	5,170
19-20	11.3	54,900	10,170	17,700	5,270	17,500	6,000
20-21	11.9	57,300	11,100	16,600	4,650	18,400	5,640
Average	11.5	54,500	10,900	16,900	4,920	18,200	5,600
Structural Mill Wastes							
June 19-20	0.97	4,000	581	872	137	840	194
20-21	0.96			870	176	904	111
(8AM-4PM)							
Average	0.965	4,000	581	871	156	872	152
Combination Slab-Bloom and Plate-Strip Wastes							
June 17-18	8.5*	43,900*	13,500*	13,900*	7,000*	8,560*	9,700*
18-19	15.3	71,900	17,800	24,400	7,800	22,200	8,390
19-20	15.2	72,600	14,400	26,000	8,600	37,600	10,600
20-21	15.8	82,600	24,500	27,100	11,300	20,500	8,890
Average	15.4	75,700	18,900	25,800	9,230	26,800	9,300
Rolling Mill Drain							
June 17-18	4.7*	22,400	8,060	5,830	2,940	3,800	3,510
18-19	9.3	42,900	7,590	14,200	4,490	13,900	6,090
19-20	9.3	44,100	14,100	12,600	4,800	13,600	5,590
20-21	9.3	43,600	14,400	14,000	5,570	12,100	5,310
Average	9.3	45,200	12,030	13,600	4,950	13,200	5,660

* Not included in average as plate-strip mill operated only 1/3 of day.

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SECTION D - PLANT WATER USE

There are four separate water systems, namely: untreated, treated, domestic, and boiler water.

DISCUSSION OF WATER SYSTEM

1. Untreated Water System

(1) Sources - The untreated water supply system is shown in Figure D-1. The three main sources are irrigation canals or ditches, wells, and recirculated process water. Process water is returned from such operational units as the acetylene plant clarifier, blast furnace gas washer water clarifiers, and rolling mill scale pits. Irrigation canal water and most of the recirculated water are discharged into a common collection basin, which acts as a settling basin. They flow through a Dorr thickener and then through a tunnel to the power house pumps, where the water is pumped through the plant. Water, in excess of demand, flows over a weir from the collection basin into a ditch draining to the main outfall settling-skimming basins. The sewage treatment plant effluent is chlorinated before flowing directly into feed line between the thickener and the main pumping station.

The sources and volumes of water pumped to the untreated water system during the period of the survey are shown in Table D-1. The total daily flows are in column 9, and the average daily total was 19.08 mgd.

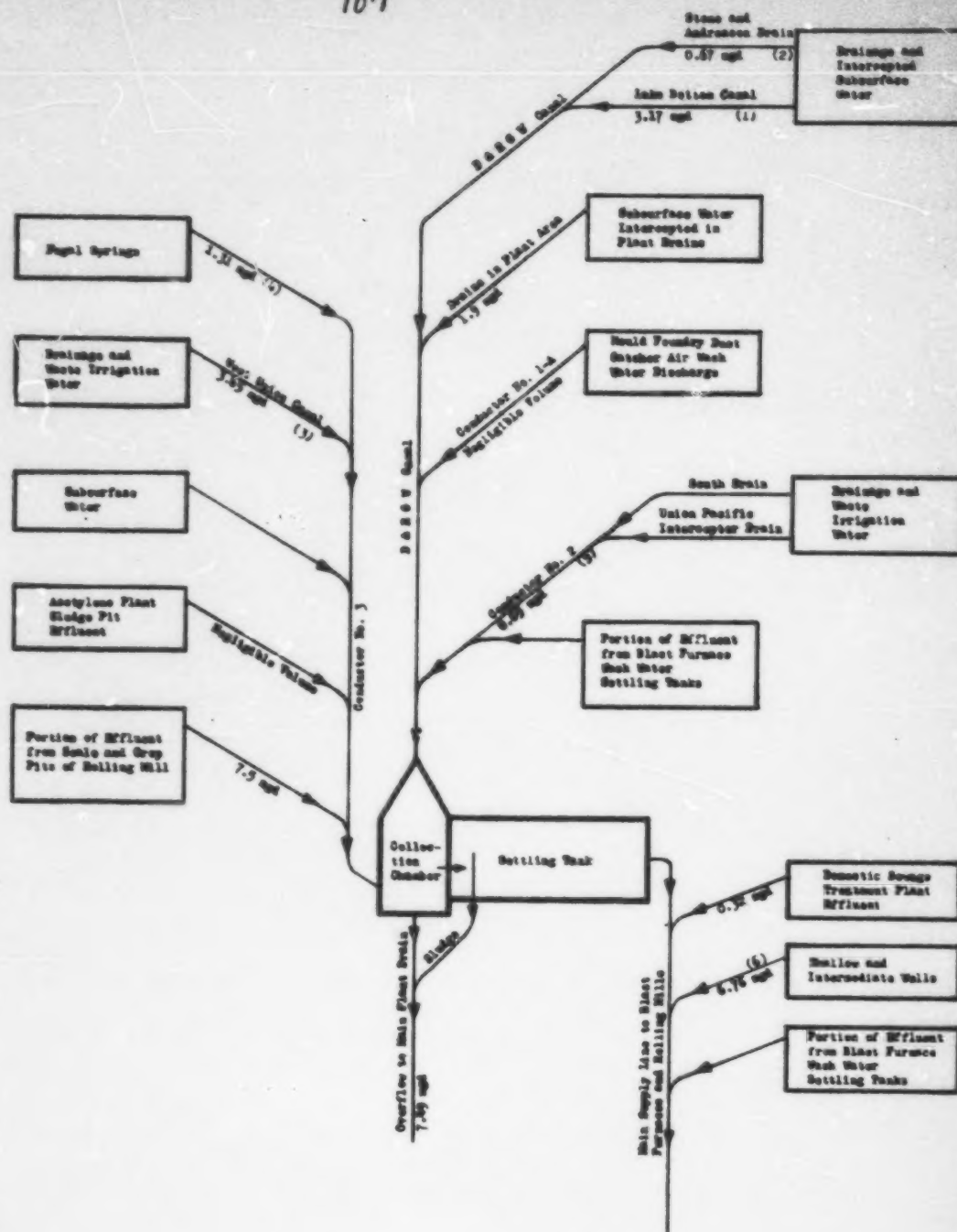


Figure 2-1

Geneva Steel Company, Geneva, Utah

WATER SUPPLY SOURCES

Environmental Health Center
Cincinnati, Ohio, June, 1951

Dr. W. C. H. A. Eng. No. 14-51-13

(2) Uses - There are three untreated water pumps capable of delivering 14,000 gpm each. The bulk of the untreated water was distributed during the period of the survey as follows:

(a) Blast furnace area

Gas washers	8,140 gpm
Pig machine (when operating)	1,000
Sintering plant	150

(b) Rolling mill

Slab and bloom mill	1,757
Plate mill	5,889
Structural mill	<u>681</u>

Total 17,617 gpm = 25.37 mgd.

Untreated water is also available for fire protection, emergency open-hearth furnace cooling, and lawn sprinkling.

2. Treated Water System

Most of the treated water is recirculated to an open reservoir with a capacity of 1,000,000,000 gallons and a water surface area of 312 acres. This reservoir serves as a cooling device. Sulfuric acid is added to the water pumped from the reservoir to prevent scale deposition in the system.

(1) Sources - There are two sources of supply for the treated water system. A deep well furnishes 1000 gpm and the Olmstead pumping station is capable of furnishing 4000-8000 gpm. This station obtains water from either or both Deer Creek and Provo River.

(2) Uses - Treated water is used mainly for cooling purposes.

Approximately 1522 gpm are used for washing the electrodes of the electrical precipitators used for cleaning blast furnace gas. Treated water is also used for supplementing the coke quench supply.

The treated water is distributed as follows:

(a) Power Station

Turboblower condensers 44,100 gpm

Turbogenerator condensers 52,000

(b) Process Units

Coke plant 12,000

Blast furnace area 16,550

Open-hearth furnaces 16,000

Rolling mill 9,000

Total 149,650 gpm = 215,496 mgd.

(3) Losses - The treated water system is essentially a closed one, but there are some operational losses. The main losses are approximately as follows:

Coke plant 700 gpm

Blast furnace area 1,520

Rolling mill 3,000

Reservoir evaporation
and seepage Not known.

3. Domestic Water System

The domestic water system supplies all the sanitary water for the plant. Water from wells is softened in two zeolite units, chlorinated, and pumped into the system. Consumption amounts to approximately 500 gpm and most of it occurs in the sanitary and office buildings.

4. Boiler Water

Water softened by the lime-soda ash process is used for boiler make-up in the powerhouse and the open-hearth waste heat boilers. It is obtained from the Olmstead pumping station which draws water from Deer Creek and/or Provo River. Approximately 100 gpm are used in the powerhouse and 250 gpm in the open-hearth waste heat boilers.

SURVEY PROCEDURES

5. Sample Collection

Samples were collected by plant personnel from the following points at the time of the survey:

(1) Untreated Water -

- (a) Lake bottom canal
- (b) Stone and Andreason drain
- (c) West Union Canal
- (d) Fugal spring
- (e) Conductor number 2
- (f) Well supply
- (g) Drains in plant area.

(2) Treated Water at Power House - The samples were collected at hourly intervals over 24-hour periods from 8:00 AM to 8:00 AM. Untreated water samples were taken from the various sources and composited into one sample according to flows. Equal increments were taken for the treated water composites.

Separate composite samples were collected for the cyanide, phenol and sulfide determinations. The cyanide samples were preserved by adding pellets of sodium hydroxide to the sample bottles before sampling. The sulfide samples were preserved by adding approximately a gram of zinc acetate to each gallon bottle before sampling. The phenol samples were preserved by adding approximately 4 grams of copper sulfate to separate gallon bottles before sampling.

6. Flow Measurements

(1) Untreated Water - Flow measurements were made at each sampling station by means of weirs and Parshall flumes installed by the Geneva Steel Company. The well supply was metered.

(2) Treated Water - Recorded meter readings were used for flow measurements.

7. Laboratory Procedures

The following determinations were made on the samples collected:

Total solids, total and volatile

Suspended solids, total and volatile

Iron, total and dissolved

Alkalinity

pH

Cyanides

Oils

B.O.D., 5-day

Sulfides (total) (methylene blue method)

Phenols

Ammonia nitrogen (free)

Thiocyanates

Chlorides.

In general, the procedures followed were as given in "Standard Methods for the Examination of Water and Sewage," 9th Edition. (1)

Special procedures for the phenols, cyanides, thiocyanates, iron and oils were used and will be found in the appendix at the end of this report.

8. Explanation of Laboratory Analyses

A brief explanation of the various laboratory determinations is given in the appendix at the end of this report and is intended to serve as an aid in the interpretation of the analytical results reported.

SUMMARY OF RESULTS

9. Water Sources

The total available water supplies are as follows:

Untreated water collection system	19.07 mgd
Treated water system	
Deep well	1.44
Provo River and Deer Creek	11.52
Domestic water system	<u>1.01</u>
Total	33.04 mgd.

10. Water Consumption

The total volumes of water pumped for plant use during the period of the survey are as follows:

Untreated water system	25.37 mgd
Treated water system	215.496
Domestic water system	.72
Boiler water system	<u>.504</u>
Total	242.090 mgd

11. Water Characteristics

The characteristics of the water supplies are given in Table D-2.

The average daily concentrations of significant constituents are as follows:

	<u>Untreated Water</u>	<u>Treated Water</u>
Suspended Solids	35.8 ppm	17. ppm
Total iron (Fe)	1.79	0.41
Cyanides (CN)	0	0
Oil	0	0
B.O.D., 5-day	1.77	10.7
Phenols	0	0
Ammonia nitrogen (free)	0	0
Sulfides (S)	0	0
Thiocyanates (NH_4SCN)	0	0

Genova Steel Plant
Genova, Utah

Table D-1 -
Water Supply and Outfall Sewer Flows

(Expressed in million gallons per day)

May: (1951)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Lake Bottom Canal	Stone & Anderson Drain	West Union Canal	Fugal Springs Canal	Conductor #2	Well Supply	Drains in Plant Area	Domestic Sewage	Total Untreated Water	Treated Water to Sewers	Total Water to Plant	Main Outfall Sewer	South Outfall Sewer	Total Outfall Sewers	Untreated Water Overflow	Water Used in Plant
22																
23	3.82	.74	4.20	1.71	.65	6.53	1.94	.32	19.91	6.59	26.50	26.63	.05	26.68	8.66	18.02
24																
25	5.06	.7	3.46	1.57	.65	6.92	1.94	.31	20.88	6.59	27.47	29.21	.05	29.26		
26																
29	3.23	.65	3.09	.94	.65	6.46	1.94	.33	17.29	6.59	23.88	24.82	.06	24.88	6.46	18.42
30	2.59	.65	3.84	1.02	.65	7.24	1.94	.32	18.25	6.59	24.84	24.75	.06	24.81	7.37	17.44
31	3.67	.75	3.64	1.31	.65	6.78	1.94	.32	19.08	6.59	25.67	26.35	.055	26.41	7.49	17.96

Geneva Steel Plant
Geneva, UtahTable D-2 - Analyses of Samples from Water Supply
Lines and Outfall Sewer Lines (Parts per million)

Date	Sample No.	Total Solids	Susp. Solids	Iron		Alk	pH	Cyanide (CN)	Oil	BOD 5-day	Sulfide (S)	Phenols	Ammonia free	Thiocyanate
1951		Tot	Vol.	Tot	Vol.	Tot	Dis	Tot						MLN SCH
Untreated Water Supply														
May														
22-23	B1	443	103	34	9.1	1.20	0	255	8.3	0	0	0.45	0	0
24-25	B21	427	90	31	12.1	.76	0	256	8.2	0	0	2.04	0	0
28-29	B41	454	150	38	7.7	3.01	0	260	8.2			2.01		0
29-30	B51	456	124	42	4.1	2.19	0	248	8.1			2.60		0
Avg.		445	116	36	8.2	1.79	0	254	8.1-8.3	0	0	1.77	0	0
Treated Water Supply (to Power House)														
May														
22-23	B2	374	94	13	9	.25			8.3	0		12.1	0	0
23-24	B12	364	78	18	14	1.1		130	8.0	0		10.8	0	0
27-28	B32	380	86	21	13	0		135	8.3	0		11.0	0	0
30-31	B62	384	88	10	10	0		138	8.3	0		9.0	0	0
June														
17-18	B72	374	120	11	10	0.7								
18-19	B82	378	86	18	17									
19-20	B92	406	80	18	14									
20-21	B102	388	126	25	15									
Avg.		381	94.8	17	12.8	.41		134	8.0-8.3	0		10.7	0	0
Inflow to Skimming-Settling Ponds														
May														
22-23	B9			230	34	144			8.3	0.2	10.2	12.2	.34	0.88
24-25	B29	596	152	150	58	113		216	8.4	0	36	6.0		
28-29	B49	732	222	332	84	195		213	8.1	0.2	23		.08	
29-30	B59	598	134	200	38	114			8.0	0	21.6		.25	
June														
17-18	B79										23.2			
18-19	B89	696	156	267	48						58.2			
19-20	B99	850	130	370	56						35.3			
20-21	B109	590	190	170	54						40.9			
Avg.		677	164	246	53.1	143		215	8.0-8.4	0.1	31.7	9.1	.22	0.88
Main Outfall Sewer Discharge														
May														
22-23	B10	492	56	32	5	14.5			8.4	0.2	0	5.4	0	.06
24-25	B30			86	26	14	0	239	8.3	0	4.9	6.0		.02
28-29	B50	433	106	31	18	19.1	0	216	8.1	0.2	0	5.7	0	.00
29-30	B60	456	120	42	3	19	0	208	8.2	0	0	10.9		.07
June														
17-18	B80										21.3			
18-19	B90	464	94	40	16						15.1			
19-20	B100	506	36	35	13						7.5			
20-21	B110	500	110	37	15						6.9			
Avg.		476	87	45.6	13.7	16.7	0	221	8.1-8.4	0.1	7.0	7.0	0	.038
South Sewer Discharge														
May														
24-25	W1			64	26	6.9		190	8.0	0	0	19.5	0	3.25
28-29	W11	474	140	13	8	5.0		207	7.9	0	0	5.6	0	.40
Avg.		474	140		17	6.0		199	7.9-8.0	0	0	12.6	0	1.83

Contents, Section 2 - Process Waste Lines

WASTE TREATMENT SYSTEM - 2. WASTE LINES

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SECTION B - PROCESS WASTE LINES

There are two outfall sewers leading from the plant to Utah Lake: the south sewer and the main (north) sewer. The plant sewer systems are shown in Figure 2-1.

DISCUSSION OF SEWER SYSTEM

1. South Sewer

The South Sewer is an open ditch draining the wastes from a few auxiliary buildings in the southern part of the plant area. These minor operational units are as follows: production laboratory, pig machine, garage, maintenance shops, cinder yard and mold preparation building. The wastes from this sewer drain into the Lake Bottom Canal before finally reaching Utah Lake.

2. Main Outfall Sewer

The main outfall sewer is an open ditch and drains the wastes from all the main plant operational units to Utah Lake. The main waste lines discharging into this sewer are: blast furnace area drain, rolling mill drain, effluent from benzol plant pond, and overflow from untreated water collection basin.

Two settling-skinning ponds have been installed in the main outfall ditch and operate in parallel. They are approximately 600 feet long, 30 feet wide, and 9 feet deep. Oily wastes and other floating materials are periodically removed at the outlet ends. Mechanical

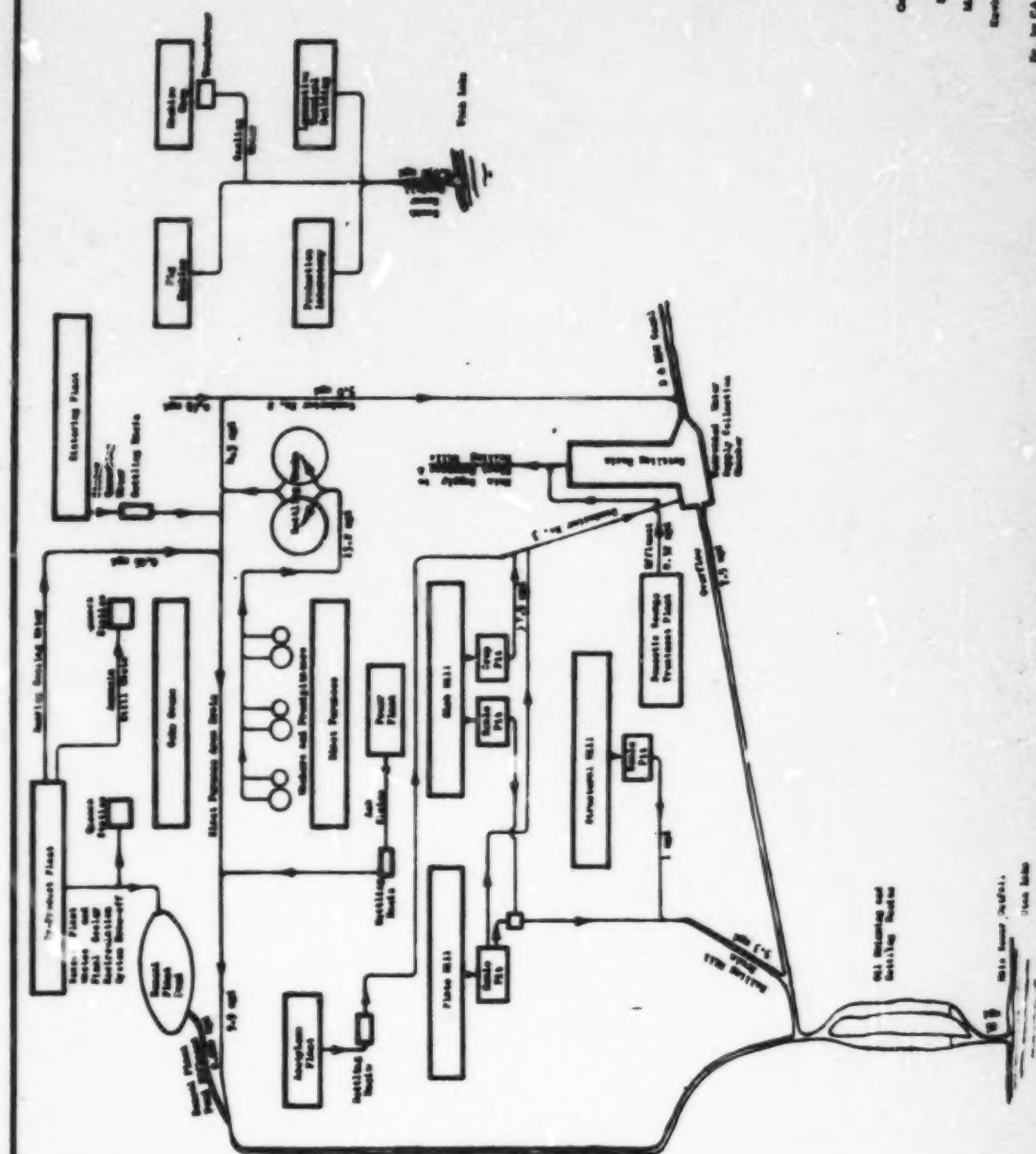


Figure 1-1

Chenier, Bird Company
Carmel, Calif.

Schweitzer Industries

MADE IN THE U.S.A.

Environmental Health Cost
Chickadee, Ohio

Dr. W. C. A.

self-operating skimming devices are being purchased for each pond. Settleable solids are dredged out of the ponds whenever the suspended solids content of the final effluent exceeds 50 ppm. The sludge usually reaches a depth of about three feet before being removed.

The theoretical detention time of the ponds is about two hours (based on flows). The actual flow-through time, after dredging, was 45 minutes as measured by the use of fluorescein dye.

SURVEY PROCEDURES

3. Sample Collection

Samples were collected by plant personnel from the following points at the time of the survey:

- (1) Benzol plant pond effluent
- (2) Blast furnace area drain
- (3) Rolling mill drain
- (4) Main outfall sewer drain
- (5) South outfall sewer drain.

Flow measurements were taken for the overflow from the untreated water collection basin (See Item 4-(6)) but no samples were taken for analyses.

Weighted samples were collected at definite time intervals for 24-hour periods from 6:00 AM to 6:00 AM and composited.

Separate composite samples were collected for the cyanide, phenol and sulfide determinations. The cyanide samples were preserved

by adding pellets of sodium hydroxide to the sample bottles before sampling. The sulfide samples were preserved by adding approximately a gram of zinc acetate to each gallon bottle before sampling. The phenol samples were preserved by adding approximately 4 grams of copper sulfate to separate gallon bottles before sampling.

4. Flow Measurements

Flow-measuring devices were installed by the Geneva Steel Company.

(1) Benzol plant pond effluent flows were measured with a 9-inch Parshall flume. Flow level readings were taken at the time of sampling.

(2) Blast furnace area drain flows were measured with a 3-foot Parshall flume. Continuous readings were obtained with a float level recorder.

(3) Rolling mill drain flows were measured with a 3-foot Parshall flume. Continuous readings were obtained with a float level recorder.

(4) South sewer drain flows were measured with a 2-foot Cippoletti weir. Flow level readings were taken at the time of sampling.

(5) Main outfall sewer flows were measured with a 5-foot Parshall flume. Continuous readings were obtained with a float level recorder.

(6) Untreated water basin overflows were measured with a Cippoletti weir. Continuous readings were obtained with a float level recorder.

5. Laboratory Procedure

The following determinations were made on the samples collected:

Total solids, total and volatile

Suspended solids, total and volatile

Iron, total and dissolved

Alkalinity

pH

Cyanides

Oil

B.O.D.

Sulfides (total)

Phenols

Ammonia nitrogen (free)

Thiocyanates

Chlorides

In general, the procedures followed were as given in "Standard Methods for the Examination of Water and Sewage," 9th Edition.⁽¹⁾

The methylene blue method for sulfides was used.

Special procedures for the phenols, cyanides, thiocyanates, iron and oils were used and will be found in the appendix at the end of this report.

6. Explanation of Laboratory Analyses

A brief explanation of the various laboratory determinations is given in the appendix at the end of this report, and is intended

to serve as an aid in the interpretation of the analytical results reported. The process waste lines are shown in Figure B-1, and the flows are shown in Table B-1. The average daily concentrations and quantities of significant waste constituents are as follows:

SUMMARY OF RESULTS

The process waste lines are shown in Figure B-1, and the flows are shown in Table B-1.

7. Waste Lines Flowing into Main Outfall Sewer

(1) Benzol Plant Pond Effluent - (See Item 27, Section B).

The analyses of samples and the quantities of waste constituents are given in Tables B-1 and B-2. The average daily concentrations and quantities of significant waste constituents are as follows:

	Concentration ppm	Gross Quantities lbs./day	Net Quantities lbs./day
Oil	67.3	12.9	12.9
Cyanides (CN)	6.1	.81	.81
Sulfides (S)	56	.28	.28
Phenols	315	44.7	44.7
Thiocyanates (NH_4SCN)	132	15.1	15.1
B.O.D., 5-day	992	136	134
Ammonia nitrogen (free)	24.8	3.6	3.6

These wastes represent the total significant water-carried wastes flowing from the coke plant.

(2) Blast Furnace Area Drain - (See Item 19, Section A).

The analyses of samples and the quantities of waste constituents are given in Tables A-2 and A-3. The average daily concentrations and quantities of significant waste constituents are as follows:

	Concen- trations ppm	Gross Quantities lbs./day	Net Quantities lbs./day
Suspended solids (total)	155.	8300	5590
Total iron (Fe)	94.	4770	4640
Cyanides (CN)	.75	59	59
Sulfides (S)	.60	52	52
Ammonia nitrogen (free)	1.77	150	150

(3) Rolling Mill Drain - (See Item 9, Section C).

The analyses of samples and the quantities of waste constituents are given in Tables C-2 and C-3. The average daily concentrations and quantities of significant waste constituents are as follows:

	Concen- trations ppm	Gross Quantities lbs./day	Net Quantities lbs./day
Suspended solids (total)	175.	13,600	9,870
Total iron (Fe)	170.	13,200	12,000
Oil	73.1	5,660	5,650

8. Skimming-Settling Ponds

(1) Characteristics and Quantities of Wastes - The analyses of samples and the quantities of waste constituents are given in Tables

D-2 and H. The average daily concentrations and quantities of significant waste constituents are as follows:

	<u>Influent</u>		<u>Effluent</u>	
	Concentration ppm	Quantities lbs./day	Concentration ppm	Quantities lbs./day
Suspended solids (total)	249.	49,400.	44.	9,120.
Total iron (Fe)	143.	31,000.	16.7	3,610.
Cyanides (CN)	.1	21.5	.1	21.5
Oil	31.7	6,220.	7.0	1,310.
B.O.D., 5-day	9.1	2,070	7.0	1,510.
Phenols	.22	47.6	.036	7.8
Ammonia nitrogen (free)	.88	194.	.71	154.
Sulfides (S)			0	0.
Thiocyanates (NH ₄ SCN)			0	0

(2) Removal of Significant Wastes - The average quantities removed and per cent removals of significant waste constituents are as follows:

	<u>Quantities Removed lbs./day</u>	<u>Per Cent Removal</u>
Suspended solids (total)	40,280	81.5
Total iron (Fe)	27,390	88.3
Cyanides (CN)	0	0
Oil	4,910	79.0
B.O.D., 5-day	560	27.0
Phenols	39.8	83.6
Ammonia nitrogen (free)	40	20.6

9. South Outfall Sewer

The analyses of samples and the quantities of waste constituents are given in Tables D-2 and E-1. The average daily concentrations and quantities of significant waste constituents are as follows:

	Concen- trations ppm	Gross Quan- tities lbs./day	Quantities in Water Supply lbs./day	Net Quan- tities lbs./day
Suspended solids (total)	38.5	16.5	8.5	8.
Total iron (Fe)	5.95	2.67	.2	2.47
Cyanides (CN)	0	0	0	0
Oil	0	0	0	0
B.O.D., 5-day	12.6	5.44	5.3	.14
Phenols	0	0	0	0
Ammonia nitrogen (free)	1.83	.77	0	.77
Thiocyanates (NH_4SCN)	0	0	0	0

10. Gross and Net Wastes Discharged from Plant

The average daily gross and net quantities of significant waste constituents discharged by the plant to Utah Lake are as follows:

	<u>Total Gross Quantities lbs./day</u>	<u>Quantities Contributed by Water Supplies lbs./day</u>	<u>Total Net Quantities lbs./day</u>
Suspended solids (total)	9130.	6820	2310.
Total iron (Fe)	3610.	314	3296.
Cyanides (CN)	21.5	0	21.5
Oil	1310.	0	1310.
B.O.D., 5-day	1520.	893	627.
Phenols	7.8	0	7.8
Ammonia nitrogen (free)	155.	0	155.
Sulfides	0	0	0
Thiocyanates (NH_4SCN)	0	0	0

The treated water supplies were not sampled at their sources, but at the powerhouse in the line from the reservoir. The concentrations of waste constituents were representative of the supplies, with the exception of the 5-day B.O.D. (10.7 ppm) which was unusually high.

Geneva Steel Plant
Geneva, Utah

Table B-1 - Quantities of Waste Constituents in Sewer Lines
(Pounds)

Date 1951	Sam- ple No.	Flow MGD	Total Solids		Susp. Solids		Iron		Alka- linity Total	Cya- nide (CN)	Oil	BOD 5-day	Sul- fide (S)	Pho- pho- rus	Ammonia Nitrogen (free)	Thio- cyanates mg/l
			Total	Volu- tile	Total	Volu- tile	Total	Dis- solved								
Influent to Skimming - Settling Ponds																
May																
22-23 B9		26.63			50,779	7,507	31,792		44,461	44.2	2,252	2,694		75.1	194	
24-25 B29		29.21	144,447	36,839	36,354	14,057	23,598		43,567	0	8,725	1,454				
28-29 B49		24.82	150,675	45,696	68,339	17,291	40,139			41.1	4,734			16.5		
29-30 B59		24.75	122,596	27,471	41,002	7,790	23,371			0	4,428			51.3		
June																
17-18 B79		21.71									5,081					
18-19 B89		22.55	130,267	21,198	49,973	8,984					10,893					
19-20 B99		22.81	160,925	24,612	70,050	10,602					6,653					
20-21 B109		20.55	100,633	32,407	28,996	9,211					6,976					
Avg.		24.11	134,924	32,704	49,356	10,777	30,975		44,064	21.3	6,221	2,074		47.6	194	
Main Outfall Sewer Discharge																
May																
22-23 B10		26.63	108,624	12,364	7,065	1,104	3,201		57,924	44.9	0	1,192	0	13.2	194	
24-25 B30		29.21			21,323	6,301	3,393		0	0	1,133	1,454	0	3.6	160	
28-29 B50		24.32	90,153	21,819	6,331	3,705	3,932		44,461	41.1	0	1,173	0	0	165	
29-30 B60		24.75	93,485	24,601	8,610	615	3,895		42,642	0	0	2,235		14.4	98	
June																
17-18 B80		21.71									3,838					
18-19 B90		22.55	86,845	17,594	7,487	2,995					2,826					
19-20 B100		22.81	95,797	6,816	6,626	2,461					1,420					
20-21 B110		20.55	85,283	18,762	6,310	2,553					1,177					
Avg.		24.11	93,365	16,992	9,115	2,820	3,605	0	48,342	21.5	1,306	1,514	0	7.3	154	0
South Outfall Sewer																
May																
24-25 W1		0.05			26.6	10.8	2.86		78.9	0	0	8.09		0	1.35	
28-29 W11		.06	236	69.7	6.5	4.0	2.49		103.	0	0	2.79		0	.20	
Avg.		0.055	236	69.7	16.5	7.4	2.67		90.9	0	0	5.44		0	0.77	

ACKNOWLEDGMENT

It is desired to express appreciation to the management of the Geneva Steel Company for affording this opportunity of studying wastes from this type of plant, and also for the fine co-operation shown and the assistance provided in the conduct of the survey.

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G. N. McDermott
Sr. Asst. Sanitary Engineer

D. M. Taylor
Public Health Engineer

BIBLIOGRAPHY

- (1) American Public Health Association, "Standard Methods for the Examination of Water and Sewage," 9th edition, 1946.

APPENDIX F

It is desired to express appreciation to the members of the
 the General Land Office for their assistance in the preparation
 of this report. The work was done under the supervision of
 the Chief of the Bureau of Land Management, and the assistance
 of the various divisions of the Bureau. The work was done
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APPENDIX F

Explanation of Laboratory Analyses

and

Special Procedures for Analyses

1. The analyses were made by the Bureau of Land Management,
 and the results are given in the following table.

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I. EXPLANATION OF LABORATORY ANALYSES

A brief discussion of the significance of the various laboratory determinations is given below for the purpose of aiding in the interpretation of the analytical results reported.

1. Phenols

The phenol results, as reported, represent the gross quantity of phenolic constituents such as phenols, cresols, etc. These substances are found in variable proportions and amounts in certain types of industrial wastes. They may result, as in by-product coke and gas plant wastes, from the pyrolysis of coal.

Phenols may cause tastes and odors in water supplies. Concentrations of as little as 0.002 to 0.005 ppm phenols may produce chlorophenol (medicinal) tastes and odors in the presence of chlorine in water. A concentration of 0.1 ppm of phenol alone will impart the characteristic taste and odor of phenol to water. Phenolic compounds are toxic to aquatic life, with lethal limits being dependent on such factors as concentration, time of exposure, and the characteristics of the water. The minimum concentration of phenol reported as being toxic to fish is 0.4 ppm.⁽¹⁾ Fish exposed to phenolic compounds in water will acquire the tastes and odors of these compounds.

2. Cyanides

The cyanide results are reported in terms of CN and represent the so-called "free" cyanides which include the normal salts of HCN as well as any HCN present. Cyanides are very toxic, and concentrations

as low as 0.05 to 0.1 ppm have been reported as killing fish.⁽¹⁾ Minimum lethal concentrations vary for different species of aquatic life and are influenced by such factors as time of exposure, the characteristics of the water, and temperature.

3. Thiocyanates

The thiocyanate results are reported in terms of NH_4SCN and represent the salts of thiocyanic acid for the most part because thiocyanic acid is very unstable. Thiocyanates are of interest when considering wastes from the carbonization of coal. Cyanides are readily converted to thiocyanates in the presence of sulfur and sulfides, and these thiocyanates are more stable compounds than the cyanides. Thiocyanates themselves have been reported as being relatively nontoxic to aquatic life.⁽²⁾ They are capable, however, of combining with chlorine to form cyanogen chloride which has been reported as being lethal to fish in a concentration of 0.1 ppm.⁽³⁾

4. Sulfides

The sulfide results are reported in terms of S and represent the total sulfides, which include the salts of H_2S as well as any H_2S present. Sulfides are objectionable from the standpoint of stream pollution. They are strong reducing agents and create oxygen demands. Sulfides, and particularly hydrogen sulfide, are very toxic to fish, with the minimum lethal concentrations being dependent on such variables as time of exposure, pH, temperature, and dissolved oxygen concentration. Concentrations of sulfide as low as 0.5 to 1.0 ppm have been reported as being critical under average water quality conditions.⁽³⁾

5. Ammonia

The ammonia results are reported in terms of free, fixed, and total ammonia nitrogen (N). The free ammonia nitrogen represents ammonia in solution and is typical of the ammonia removed in the free leg of an ammonia still. The fixed ammonia nitrogen was determined by making the sample, from which the free ammonia was distilled, alkaline to phenolphthalein and distilling off the ammonia. It corresponds to the ammonia removed in the fixed leg of an ammonia still. The total ammonia nitrogen represents the sum of the free and fixed ammonia nitrogen.

Solutions of ammonia, or ammonium hydroxide, and also of ammonium salts, can be very toxic to fish even when the pH is not very high (that is, below pH 9).⁽³⁾ The toxicity of these solutions evidently is dependent largely on the concentration of the undissociated base (NH_4OH), which increases with the pH value, as well as with the over-all ammonium content. A concentration of the non-ionic free ammonia, or ammonium base of 1.2 to 3 ppm (as NH_3) has been reported to be quite rapidly and uniformly toxic to a relatively hardy species in solutions of varying pH and ammonium ion content. Several investigators have reported that the addition of only 2 to 7 ppm of ammonia (as NH_3) to certain waters proved lethal to some fish.

6. Oils

The oil results were obtained by extracting the samples with a 1:1 mixture (by volume) of diethyl ether and carbon tetrachloride. These results represent all of the materials which are soluble in

these organic solvents, and not just the true oils as such.

Oily materials are objectionable from the standpoint of stream pollution because they are unsightly, damaging to wildlife and aquatic life, detrimental to recreational facilities, and interfere with treatment processes for public and industrial water supplies. Oily films on the surfaces of lakes and streams interfere with the normal re-aeration of the water and may be difficult to remove. Certain sludges may contain oily materials which may be toxic to bottom fauna and flora.

7. Biochemical Oxygen Demand (B.O.D.)

The biochemical oxygen demand of sewage, polluted waters, or industrial wastes, is the oxygen (in ppm) required during stabilization of the decomposable organic matter by aerobic bacterial action. The rate of oxygen demand is dependent on both time and temperature and consequently the standard conditions of 5 days' incubation at 20°C. are usually used for the test. Approximately 68 per cent of the oxygen demand of the carbonaceous material present in normal domestic sewage is satisfied under the conditions of 5 days' incubation at 20°C. The oxygen demand rates of industrial wastes, however, may or may not follow the typical oxidation curve for domestic sewage. It would be necessary to incubate a particular sample of waste for such a period of time that no more oxygen demand was exerted, in order to determine the total B.O.D.

High B.O.D. values are objectionable from a stream pollution

standpoint because they reduce the oxygen resources of the streams, adversely affecting the aquatic life. If the oxygen content is depleted, anaerobic conditions develop and the water is rendered undesirable for supply and recreational purposes.

8. Solids

Solids analyses include those for total solids, suspended solids, and the volatile constituents of each. Suspended solids are insoluble solids which either float on the surface of the liquid, remain in suspension, or settle out on standing. They are determined by filtering samples through asbestos mats in Gooch crucibles. Total solids consist of all the solids in a sample and include both suspended and dissolved solids. Volatile solids are those solids in the sample which are lost on ignition, in a muffle furnace, of the total and suspended solids at 600°C.

Large quantities of suspended solids are objectionable from the standpoint of stream pollution because they settle out and cause silting and sludge banks. Suspended solids are also objectionable in water supplies used for domestic and industrial purposes. The volatile solids results are obtained by an empirical method but they are intended to indicate the organic material content of the solids.

9. Iron

Determinations were made for both total and dissolved iron and the results are expressed as Fe. Dissolved iron analyses were made on samples, which had been filtered through asbestos mats in Gooch crucibles,

for the purpose of determining whether or not any of the iron in the samples was in solution. The iron analyses made during this survey indicated that all of the iron was insoluble, in the form of iron oxides, ores and/or metallic iron.

Iron is objectionable in water supplies used for both domestic and industrial purposes. The Public Health Service Standards for Drinking Water state that the iron and manganese together should not exceed 0.3 ppm. Iron and iron compounds may cause bad tastes and odors in drinking water and will stain plumbing fixtures and laundered materials. Many manufacturing processes require the absence or low concentration of iron.

10. pH

The symbol "pH" denotes the negative logarithm of the hydrogen-ion normality. The pH value indicates the relative acidity or alkalinity of a solution, being lower with higher degrees of acidity.

pH data are helpful in measuring the effects of acid and alkaline wastes on natural surface waters. Acids causing pH values below 4.0 and alkalies causing pH values above 10.0 are undesirable and hazardous for fish life in waters which are not naturally so acid or alkaline. (3) pH is also an important factor when considering treatment for domestic and industrial water supplies.

11. Alkalinity

The alkalinity of a water or waste is usually caused by the presence of carbonates, bicarbonates, hydroxides, and less frequently

by borates, silicates, and phosphates. The amount of alkalinity is determined by titration with a standard solution of strong acid to certain equivalence points as given by indicator solutions. Phenolphthalein and methyl orange, or their equivalents, are used to obtain these equivalence points. Alkalinity results are expressed as parts per million of calcium carbonate (CaCO_3).

12. Chlorides

Chloride determinations were made on samples from the coke plant area for the purpose of calculating flow measurements. Dilution factors may be obtained from different chloride concentrations.

II. SPECIAL PROCEDURES FOR ANALYSIS

1. Cyanides

A. Special Apparatus

- (1) Distillation apparatus. One-liter Pyrex distilling flask, #3360, with Graham condenser, or equivalent. All-glass equipment is preferred.

B. Reagents and Solutions

- (1) Sodium hydroxide, 10% solution
- (2) Sodium hydroxide, 2% solution
- (3) Lead acetate, 5% solution
- (4) Tartaric acid, 15% solution
- (5) Methyl orange indicator (Std. Methods, 9th ed., p. 249)
- (6) p-aminodimethylbenzalrhodanine, 0.02 %, in acetone
- (7) Silver nitrate solution, 0.001 N. Dissolve 0.1699 g. AgNO_3 in 1 liter of chloride-free distilled water.

C. Procedure

- (1) Make a 200-ml. portion of the sample alkaline to phenolphthalein, using a spot plate and cautiously adding 10% NaOH solution to avoid gross excesses.
- (2) Add 10 ml. of 5% lead acetate solution and mix well.
- (3) Filter, using a fluted filter paper, and save filtrate.
- (4) Take a 105 ml. portion of the filtrate or, if appreciable quantities of NaOH have been required, take a sample which will correspond to 100 ml. of the original portion. Add 15% tartaric acid until sample is acid to methyl orange. Add an additional 1 ml. of tartaric acid solution and dilute to 500 ml.

(5) Using the all-glass distilling apparatus, distill over 50 ml., catching the distillate in a 100-ml. graduate containing 50 ml. of 2% NaOH. The delivery tube from the condenser should extend well below the surface of the liquid in the receiving vessel.

(6) Add about 8-16 drops of the p-dimethylaminobenzalrhodanine indicator per 100 ml. of sample and titrate with 0.001 N AgNO_3 until yellow color turns to light salmon pink color.

(7) Run a blank in parallel with the sample in order to determine the sensitivity of the indicator. (The same amount of indicator should be used for all titrations, depending upon the color perception of the operator).

D. Calculation

$$\begin{aligned} 1 \text{ ml. } 0.001 \text{ N } \text{AgNO}_3 &= 0.052 \text{ mg. CN} \\ \text{ppm cyanides as CN} &= \frac{(\text{ml. } 0.001 \text{ N } \text{AgNO}_3 - \text{ml. for blank}) 0.052 \times}{1000} \\ &\quad \text{ml. of sample} \end{aligned}$$

Reference: Ryan, J.A., and Culshaw, G.W. Use of p-dimethylaminobenzalrhodanine as indicator for the volumetric determination of cyanide. Analyst, 69, pp. 370-371 (1944).

2. Phenols

A. Preliminary Screening Procedure

(1) To 250 ml. of sample, add 2 ml. of 10% CuSO_4 solution and bring the pH of the mixture below 4.0 by the addition of 10% phosphoric acid solution. Put the mixture in an all-

glass distilling apparatus and distill over approximately 200 ml. Halt the distillation, and allow the distilling flask to cool until boiling ceases. Add 50 ml. distilled water to the distilling flask and resume the distillation until a total of 250 ml. plus the volume of reagents added has been distilled over.

(2) Acidify the distillate with 1 ml. of 10% phosphoric acid solution and add 5 ml. of 10% CuSO_4 solution. Transfer the mixture to a separatory funnel containing 75 g. fine-grained C.P. sodium chloride. Make three serial extractions with C.P. chloroform. On the first extraction, shake the mixture until the salt has completely dissolved. Use 50 ml. of chloroform per extraction. Collect the chloroform extracts, discarding the aqueous phase after the third extraction. Combine the chloroform extracts. Extract the chloroform twice with 75 ml. portions of 0.1 N sodium hydroxide. Discard the extracted chloroform. Combine the alkaline extracts and make it up to 250 ml., using a volumetric flask.

(3) Repeat item (1).

B. Estimation of Phenols

(A) Bromination Procedure - for phenol concentrations over 10 ppm.

(1) Take an aliquot portion of the NaOH extract obtained in the screening procedure (the portion so taken that it contains about 0.05 g. phenol) and dilute to exactly 200 ml.

- (2) Place sample in 500-ml. glass-stoppered Erlenmeyer flask and add 50 ml. of bromate-bromide solution (2.784 g. $KBrO_3$ + 10 g. KBr diluted to 1 L. with distilled water), followed by 5 ml. of conc. HCl .
- (3) After 60 minutes, add 2 g. KI .
- (4) Titrate the liberated iodine with 0.1 N thiosulfate solution in the presence of starch indicator.
- (5) Run a blank in the same manner as the sample.
- (6) Calculation of phenol

1 ml. of 0.1 N thiosulfate = 0.001567 g. phenol

$$\text{ppm phenol} = \frac{(\text{ml. for blank} - \text{ml. for sample}) 1.567 \times 1000}{\text{ml. of sample}}$$

(B) Gibbs Procedure - for phenol concentrations under 10 ppm

- (1) Use the method in Standard Methods, 9th ed., page 216. ⁽⁴⁾

Standard phenol solution may be made from C.P. phenol alone, rather than mixture of phenol and O-cresol.

3. Thiocyanates

A portion of the gas liquor is shaken up with an excess of dry lead carbonate in a flask until all the sulfide has been removed from solution. Filter, take 100 ml. of the filtrate, and acidify with dilute sulfuric acid. The acid should be added gradually to avoid the violent effervescence due to the ammonium carbonate in solution. Sodium bisulfite solution is added, followed by cupric sulfate in excess. The mixture is then raised just to a boil, and left to stand 3-4 hours.

The cuprous thiocyanate precipitate, which is frequently of a dark or black color, due to a small quantity of copper sulfide, is filtered and thoroughly washed. The washed precipitate is then boiled with an excess of sodium hydroxide and again filtered and washed. The filtrate, when cold, is acidified with dilute nitric acid, a few drops of ferric nitrate or sulfate solution added, and titrated with 0.1 N silver solution until the red color of the ferric thiocyanate just disappears. One ml. of the silver solution is equivalent to 0.00761 g. ammonium thiocyanate.

Reference: Williams, Herbert E., "Cyanogen Compounds - Their Chemistry, Detection and Estimation." Edward Arnold & Co., London. Second Edition, pp. 397-398.

4. Ammonia

A. Free Ammonia

Free ammonia was determined according to Standard Methods, 9th ed. (1) by the distillation method at pH 7.4

B. Fixed Ammonia

So-called "fixed" ammonia was determined by first distilling off the free ammonia at pH 7.4, making the sample alkaline to phenolphthalein with NaOH, diluting to 300 ml. with ammonia-free distilled water, and distilling over 200 ml. according to the procedure for free ammonia.

C. Total Ammonia

Total ammonia is the sum of free and fixed ammonia. It may

be determined by making the sample alkaline to phenolphthalein and distilling over the ammonia.

5. 011

A. Procedure

Determine the pH of the sample. If compositing is being practiced, the subsamples should be composited in a 2-liter separatory funnel and mixed before the pH is checked. If the pH is above 6.0, add 1-ml. portions of 85% hydrochloric acid until the pH falls below 6. Then add a further 10 ml. portion of 85% hydrochloric acid. If the pH of the sample is initially below 6.0, add 10 ml. of 85% hydrochloric acid without preliminary adjustment of pH. Rinse the sample container or containers with an 80-ml. portion of the extraction mixture (1:1 mixture by volume of carbon tetrachloride and diethyl ether). After the extraction mixture has been used to rinse the sample containers, transfer it to the extraction flask and shake vigorously with the sample for two minutes. The sample is allowed to stand long enough for the solvent layer to separate. The lower solvent layer is then separated. Rinse the sample container or containers with a further 60-ml. portion of solvent. Add the solvent to the sample in the separatory funnel and shake for two minutes. Separate the solvent layer and add it to the solvent already collected from the first extraction. Make a third rinsing and extraction, using a

further 60-ml. portion and the same technique as was used for the second extraction.

Put the combined extract portions into the separatory funnel with 1 liter of distilled water and shake thoroughly for two minutes. Separate the extract and wash the distilled water with 30 ml. of extraction mixture. Add the wash solvent to the separated extract. Filter the combined extract portions through a fat-free filter paper. Wash the paper three times with 5-ml. portions of solvent, combining the filtrate and the wash solvent. Evaporate the combined extract on a steam bath under a hood in a weighed evaporating dish. When the solvent has been evaporated, transfer the dish to an oven maintained at 103°C. Dry for 30 minutes and cool in a desiccator. Reweigh the dish.

B. Calculation

$$\frac{\text{Weight of oil in mg.}}{\text{Volume of sample in liters}} = \text{ppm "oil"}$$

Note: With a few samples, the solvent will not separate completely from the sample, but forms a heavy solvent-in-water emulsion which will sink to the bottom of the separatory funnel. With such samples, the emulsion should be separated. When the emulsions are all collected, they may usually be broken by shaking with 500 ml. of 1% hydrochloric acid in a separatory funnel. In rare cases, several washes may be required. Regardless of whether one or two rinses are required, the wash water should be given

one cleanup extraction with 30 ml. of solvent after the main body of the solvent has been separated. The wash solvent is separated and added to the main body of the solvent. It is then washed with water, etc.

6. Iron

A. Total Iron

(A) Reagents and Solutions

- (1) Potassium dichromate #1. Dissolved 4.3907 g. $K_2Cr_2O_7$ in distilled water and make up to 1 liter. 1 ml. = 5 mg. Fe.
- (2) Potassium dichromate #2. Dilute 200 ml. of $K_2Cr_2O_7$ #1 to 1 liter with distilled water. 1 ml. = 1 mg. Fe.
- (3) Stannous chloride #1. Dissolve 50 g. $SnCl_2$ in 100 ml. conc. HCl and dilute to 1 liter with distilled water.
- (4) Stannous chloride #2. Dilute 200 ml. of $SnCl_2$ #1 to 1 liter with distilled water.
- (5) Hydrochloric acid, C.P., concentrated.
- (6) Hydrochloric acid, C.P., 1:1 (by vol.) (6 normal).
- (7) Nitric acid, C.P., concentrated.
- (8) Perchloric acid, C.P., 60 or 72 per cent.
- (9) Sulfuric-phosphoric acid solution. Mix two parts of 1:1 (by volume) sulfuric acid with one part of 85% phosphoric acid.
- (10) Sodium diphenylaminesulfonate indicator. Dissolve 0.32 g. barium diphenylamine indicator in 100 ml. distilled water and add 0.5 g. Na_2SO_4 to precipitate barium. Settle out

the precipitate and decant the clear solution,

(11) Saturated mercuric chloride solution.

B. Procedure

(A) Low Iron Concentrations

- (1) Take a 100 or 200 ml. portion of sample
- (2) Add 2 ml. conc. HCl and 0.3 ml. SnCl_2 #1
- (3) Evaporate to about 10 ml. volume, add 2 ml. of conc. HNO_3 and boil 3-5 min.
- (4) Add 2 ml. HClO_4 , boil until fumes of HClO_4 appear and then bake dry on hot plate using low heat.
- (5) Cool slightly and add 5 ml. of 1:1 HCl, adding the first few mls. slowly and with caution.
- (6) Bring to boil to dissolve iron residue, add SnCl_2 #1 until light yellow color of FeCl_3 is evident.
- (7) Add SnCl_2 #2 dropwise until solution is just colorless. Cool under tap immediately. No excess of SnCl_2 should be present and solution should remain colorless.
- (8) Add 5 ml. of H_3Cl_2 solution in one shot and allow to stand for three minutes. (If precipitate turns dark, procedure must be repeated).
- (9) Add 5 ml. of H_2SO_4 - H_3PO_4 solution, cool under tap and dilute to 100 ml. with distilled water.
- (10) Add 6 drops of diphenylamine indicator and titrate with $\text{K}_2\text{Cr}_2\text{O}_7$ #2. The end point is a blue-purple color. Subtract the amount required for the indicator. This may be done by reading the burette as the end point is approached, taking

the reading just prior to the purple color. (The amount required for the indicator is usually one drop or 0.05 ml.).

(B) High Iron Concentrations

- (1) Take a 50-ml. portion of sample.
- (2) Add 4 ml. conc. HCl and 0.3 ml. SnCl_2 #1.
- (3) Evaporate to about 10 ml. volume, add 4 ml. conc. HNO_3 and boil for 3-5 minutes.
- (4) Add 2 ml. HClO_4 , boil until fumes of HClO_4 appear and then bake dry.
- (5) Cool slightly and add 10 ml. of 1:1 HCl, adding first few mls. slowly and with caution.
- (6) Bring to boil to dissolve iron residue, add SnCl_2 #1 until light yellow color of FeCl_3 is evident.
- (7) Add SnCl_2 #2 dropwise until solution is just colorless. Cool under tap immediately. No excess of SnCl_2 should be present and solution should remain colorless.
- (8) Add 5 ml. HgCl_2 solution in one shot and allow to stand for 3 minutes. (If precipitate turns dark, procedure must be repeated).
- (9) Add 10 ml. of $\text{H}_2\text{SO}_4 - \text{H}_3\text{PO}_4$ acid solution, cool under tap and dilute to 250 ml. with distilled water.
- (10) Add 12 drops diphenylamine indicator and titrate with $\text{K}_2\text{Cr}_2\text{O}_7$ #2. Observe same precautions in titrating as in procedure for low iron concentrations.

(C) Precautions

In both procedures, if an excess of SnCl_2 was added under step 7, boil until slight yellow color appears and repeat decolorization and cooling using SnCl_2 #2. Any excess of SnCl_2 will cause the precipitation of free mercury, dark precipitate, referred to in step (8).

(D) Calculation

$$\text{ml. K}_2\text{Cr}_2\text{O}_7 \times \text{mg. Fe/ml. K}_2\text{Cr}_2\text{O}_7 \times \frac{1000}{\text{ml. sample}} = \text{ppm Fe}$$

Note: Where mill scale is present, step (3) in the above procedures should be modified as follows:

- (3) Evaporate to dryness on the steam bath, dry in the oven at 103°C . for 1-2 hrs., and ignite in the muffle furnace at 550°C . for 1-1/2 hours.

REFERENCES

- (1) M. A. Ellis, "Detection and Measurement of Stream Pollution,"
Bulletin #22, U. S. Department of Commerce, Bureau of Fisheries.
- (2) B. A. Southgate, "Treatment and Disposal of Industrial Waste Waters,"
Department of Scientific and Industrial Research, His Majesty's
Stationery Office, London.
- (3) P. Doudoroff and M. Katz, "Critical Review of Literature on the
Toxicity of Industrial Wastes and Their Components to Fish.
I. Alkalies, Acids and Inorganic Gases," Sewage and Industrial
Wastes, Vol. 22, No. 11, Nov., 1950.
- (4) "Standard Methods for the Examination of Water and Sewage,"
9th edition, 1946, American Public Health Association.